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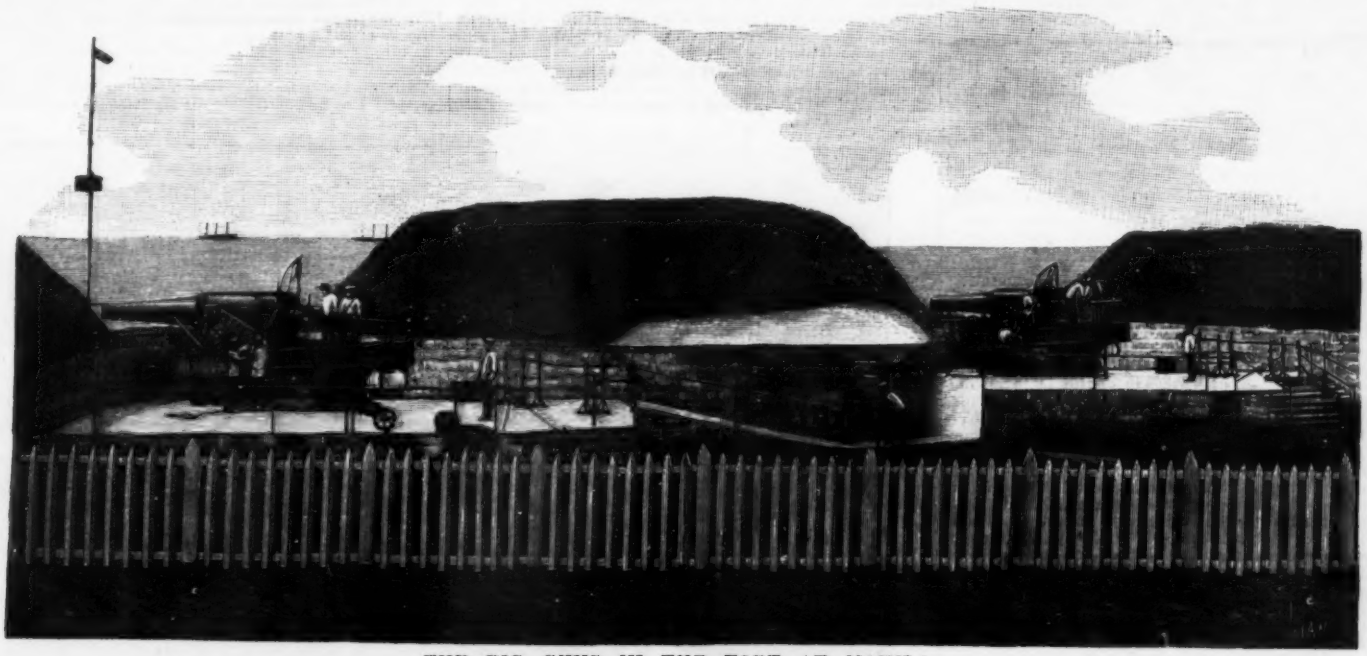
THE FORTIFICATIONS OF MANILA.

IT is always the unexpected that happens. In November, 1896, a Spanish periodical, La Ilustracion Española y Americana, in an article about the capital of the Philippines, made the following statement: "Even the strongest army would fail to capture Manila from the land, but the city has no protection of any importance against modern men-of-war." Manila has been exposed to the attacks of insurgents, and apparently her fortifications have proved adequate to repel such aggressions. But the Spaniards did not consider until quite recently the possibility of an attack *by* a hostile fleet, and the hasty preparations made when such a contingency arose were not sufficient to remedy the inferiority of these fortifications.

Manila is an old city, founded in 1571 by Miguel Lopez de Legazpi, and is admirably situated on the shores of a spacious bay which could easily accommodate all the European and American squadrons. A wide river, the Pasig, empties into the bay at Manila. Three bridges cross the river; the largest, "Puente de España" (Bridge of Spain), marks the end of a small inner harbor. As this harbor, however, affords little shelter from the monsoons, many vessels, especially those of considerable draught, seek anchorage in the harbor of Cavité, three hours to the southwest of Manila. At this point, the arsenal, together with the fort of San Felipe and the bastion Guadalupe, afford defenses which the battle of May 1, 1898, proved to be powerless against a modern fleet.

Part of the city of Manila is inclosed within a wall more than two miles long, and this part seen from the sea presents the appearance of an ancient fortress, with moats and drawbridges. Within this wall are located various government buildings, the cathedral, the palace of the archbishop and many convents. The city has many fortifications, the most important of which is the citadel or fort of Santiago commanding the walled part of the city and the mouth of the Pasig River.

Manila, however, is not by any means chiefly a military city; in fact, it would appear that fortifications



THE BIG GUNS IN THE FORT AT MANILA.

FORTIFICATIONS OF MANILA—BATTERY OF THE BASTIONS.

were erected mainly as a protection against an attack by insurgents. As a commercial center, Manila is very important, and will probably equal or even surpass Hong-Kong when it comes definitely under some other domination than the Spanish. The city now has about 300,000 inhabitants and is by far the largest city in the Philippines. The French navigator La Pérouse, who visited Manila in the eighteenth century, considered it "the best situated city in the world." Some parts of the city, particularly along the seashore and along the banks of the Pasig, are quite modern in construction. At the outskirts are found the palaces of the rich Philippine families, large and beautiful hotels and the summer residence of the captain general of the Philippine Islands. The suburb of Binondo is the business part of the city. The small proportion of business in Spanish hands is remarkable; German and British merchants have the most important establishments.

The Philippine Islands occupy a prominent position in the far East; there are 2,000 islands, upon the largest of which, Luzon, is situated the capital, Manila. The foreign element in this city is very numerous, Chinamen being very strongly represented; about 100,000 of them are said to reside there. Foreign interests in the Philippines are manifold; the protection of trade and shipping is essential to the interests of Germany and Great Britain. Great Britain besides, owing to the proximity of Hong-Kong, would have a strong political interest in the Philippines. The French possessions of Tonkin and Annam are even nearer than Hong-Kong, and the ease with which Manila might be converted into a first-class fortress will undoubtedly be an incentive to opposition in case any European nation should gain control of the Philippines. It is stated coal is found on the islands in large quantities, and if this is correct, the value of Manila as a naval base would be further increased. The future development of the Philippines will be watched with interest by the entire civilized world, and it can hardly be doubted that the present war will bring about a change in the government of these islands favorable alike to natives and foreigners. Here, as before in Japan and China, the meeting of European and American civilization will, it is to be hoped, reclaim a people which for centuries has been kept out of contact with the progress of the world.

For our illustrations, as well as for some of the data contained in this article, we are indebted to L'Illustrazione Italiana.

A NEW THEORY OF GEYSERS.

A NEW theory of the action of geysers was propounded by Prof. Porter to the members of the Physical Society at the last meeting. The theories of Bunsen and others fail to explain why the geyser throat appears almost completely full at the end of an eruption. This immediate refilling is the more remarkable when it is remembered that some geysers of the Yellowstone region discharge a million and a half gallons at each eruption, and that the eruptions may occur at five minute intervals. Moreover, the theories generally accepted assume steeper temperature gradients than those in a region like Yellowstone. Prof. Porter suggests that the phenomena are better explained on the assumption of an arrangement of strata such as exists in artesian well districts, the throat or shaft of the geyser being in the position of a well communicating with a subterranean stream—the "tube" of the geyser From the disturbed nature of the region the tube of the geyser follows a waved course; the "shaft" rises from the crest of the terminal wave; the other crests may be steam traps. Since a basinlike formation is characteristic of all geyser regions, it is fair to assume that the end of the tube remote from the shaft has an outcrop in the hills that form the sides of the basin. By means of this outcrop water continually flows into the tube. Where the tube does not sink deeply enough to attain the temperature necessary for the generation of steam, a quietly flowing hot spring is the result. But if at any point the tube descends to underground temperatures sufficiently great, steam is formed, and is trapped at the highest point of a bend. Ultimately this steam checks the flow of water, until the accumulated head of cool water from the hills overcomes the resistance, condenses the steam, and re-establishes liquid continuity. Urged by the pressure behind it, the steam is impelled toward the geyser throat; it forces the hot water before it until equilibrium is once again restored in the tube.

THE CHINESE REPEATING BOWGUN.

CENTURIES ago the Chinese, not content with inventing powder, devised repeating weapons. Despite their inventive genius, however (doubtless "bottled up" for numerous lusters), they were reduced, at the time of their war with the Japanese, to the arming of the troops of Gheugis-Khan with the bow and the matchlock gun.

Shooting with the bow is still much in favor, and, in military examinations, is of prime importance. The bowgun is widely used either as a defensive or a sporting weapon. In the first case, the weapon is a repeating one, and plays the protective role of a revolver against housebreakers, and, in the second, it is an instrument of diversion.

The repeating bowgun is very interesting. It consists essentially of an arrow magazine jointed and movable, through a powerful lever upon the stock. The magazine is a flat box, A, 16 inches in length, 5 inches in height and 1¾ in thickness, resting by its narrow side upon a piece of wood, B, with which it is intimately connected. This latter, which extends about 3 inches beyond the magazine, is provided with a groove for the sliding of the arrow. We shall call it the "barrel."

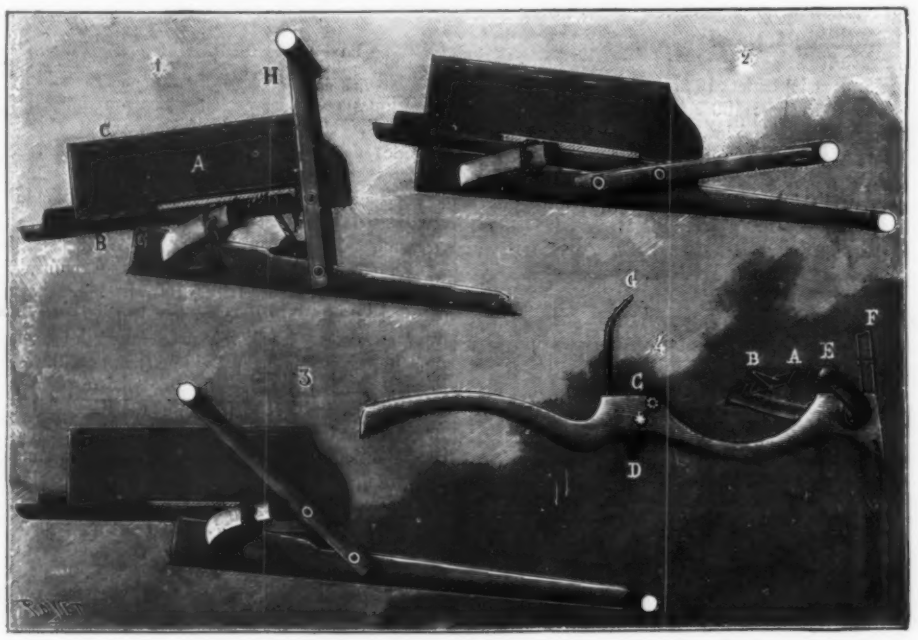
The projectiles, which consist of pieces of wood of the size of a lead pencil, tipped with a metal point, are introduced into the magazine at its upper part, which is closed by a slide, C. In the lower part of the magazine and above the barrel there is a space, D, 8 inches in length, for the passage of the bowstring. By its presence, the latter prevents the arrow from entering the groove of the barrel, into which it will not drop until the magazine has been shoved forward by the lever and the bowstring places itself at the back part of the space, D, where there is a channel, E, of which the depth is equal to the diameter of the string. The string being thus placed, the arrow falls of itself into the groove, and the bow is bent and nocked. Beneath the channel, E, there is a small piece of wood, three-quarters of an inch in length, capable of ascending and descending therein This, when the lever arm is pulled back to the end of its travel, rises and pushes the string out of the channel, E, and causes the expulsion of the projectile.

The apparatus is formed of a short and powerful bamboo bow, mounted upon a stock from 28 to 30 inches in length, provided at its back part, G, with a shallow groove 6 inches in length, in which the barrel slides. This sliding motion is brought about by means of a lever, H, fixed upon the stock of the bowgun and jointed to the magazine. The string is very strong, of the size of the little finger, and made of hog's gut. In order to brace the bow, the posterior part of the stock is held against the abdomen, the left hand is placed in front of the apparatus, and the right grasps the lever and pushes it forward. The barrel slides in the groove, G, until the string engages in the nock, E, where it is firmly fixed. The arrow then falls automatically into the barrel. The lever being pulled back, the string progressively tautens and reaches its maximum tension at the moment at which the trigger, F, rises in the channel, E, and releases it.

The magazine holds ten arrows. The range of the weapon is quite wide, say from 500 to 600 feet, and might be much greater were the arrows heavier and feathered at the shaftment. Shot from a distance of 30 feet, an arrow will penetrate a spruce plank to a depth of an inch.

With this instrument, however, the shooting is done at random, since the weapon being placed upon the abdomen, it is impossible to take aim, except approximately.

The same is not the case with the sporting bowgun, which, once regulated, is capable of being shot with precision. This bow, which is from 20 to 24 inches in length, is, as a general thing, made of horn. The string is double, being formed of two guts spaced about an inch apart. The spacing is maintained by means of small pieces of wood, A. The projectile, which consists of a ball of terra cotta, is placed in a small receptacle, B, at the back of which there is a ring of cord which, in order to brace the bow, is fixed in a catch, C, from which it is released by a trigger, D.



THE CHINESE BOWGUN.

1. Magazine thrown forward for bending the bow. 2. The bowgun at rest. 3. The bowgun ready for shooting. 4. A hunting bowgun.

The stock, which is 28 inches in length, presents two curves. The shouldering is done in the same way as with a gun, and the fact here presents some interest, since the Chinese does not place his gun against his shoulder. The sighting is done through a small piece of coral or porcelain, E, mounted upon a thread which is stretched horizontally in a metal frame, F, fixed to the front part of the stock. Back of the trigger there is piece of horn, G, 6 inches in height, which is provided at the center with a stenopeic aperture. The hunter, looking through this orifice, places the sight and the object to be shot at upon the same line. A Chinese can easily kill a sparrow at a distance of twenty paces. The projectile is not very heavy, considering the power of the bow. As it is, the ball may be fired to a distance of 250 to 300 meters.

For the illustrations and above particulars we are indebted to La Nature.

KITES: THEIR THEORY AND PRACTICE.

By Capt. B. F. S. BADEN-POWELL, Scots Guards.

THE kite, one of the oldest of inventions, familiar to everyone and to every nation under the sun, is, nevertheless, but little understood. It has always been the custom to look upon this contrivance as a toy and nothing else. Very seldom, indeed, until the last few years, has it been put to any practical use. Yet it is full of promise, and those few who have made regular and careful experiments in this line have all been impressed with the satisfactory results obtained. A kite sailing in a wind gives a very considerable pull on its line, which pull can be converted into lifting power or tractive power. This appliance may then be used for lifting great weights, such as that of a man, high into the air, or it may be used for towing carts or boats. Kites can be made to ascend to very great heights, carrying up automatically registering meteorological instruments, or may carry a string to communicate with places a long distance off. Why, then, it may be asked, are they not more often made use of? I believe the sole reason is that so few men have devoted any time to studying the theory of their actions, and that when the well known rule-of-thumb patterns are departed from innumerable difficulties crop up, and the apparatus, for some inexplicable reasons, becomes frequently unsatisfactory, so that a cursory investigation of the subject only opens up a vista of obstacles apparently almost impossible to surmount.

But with a little practice and study the way becomes somewhat clearer, and, as we grope along, fresh discoveries are made which raise our hopes and show what great results we may possibly attain.

I. PRACTICAL EXPERIENCES.

Having devoted a considerable time to researches in this line, and with a view of throwing some light on the intricacies and difficulties to be met with in kite flying, I will briefly relate my own personal experiences in this subject. To begin with, I had one definite object in view. For some time I had been interested in and had practically worked with captive balloons for military purposes, and finding the behavior of them so erratic in strong winds, to say nothing of the difficulties of construction and inflation with gas, and of the cumbrousness of the necessary apparatus, I was looking about for some other means by which a man might be lifted to a height above the ground. Kites naturally soon suggested themselves, and, on investigation, I found that trials had actually been made on several occasions to lift a man by this means, but that the trials had invariably proved failures.

In 1887 I made several trials with small cambric kites. The largest of them was 10 feet high and had two cross-pieces about 4 feet wide. This only lifted a weight of 2 pounds, which was attached to the tail. Many varieties of kites were tried. Some were of the ordinary diamond pattern, some had a bowed top; one was circular. I even got a kite to fly which was absolutely frameless. However, I came to no very definite conclusions, my experiments were knocked off, and I had no opportunity of continuing them for five years.

In 1892 I made trials with a 20 square foot kite, from which I obtained two most important results. The first was that I found it possible to do away with that appendage known as a "tail," which I had hitherto presumed to be indispensable, and the second result was that by attaching a bag to the string some distance from the kite I found I could put weights into it until the kite was able to lift a weight of 6 pounds or more in a fairly strong, though not exceptional, breeze. This result, the lifting of 0·3 pound per square foot of kite surface, was most encouraging, and convinced me that under such circumstances I should be able to lift a man with a kite of 500 square feet. I, therefore, determined to go to a suitable place and carry out a regular series of experiments for a week or two. I thus learnt many lessons, one of the principal being to appreciate the fickleness and variability of the wind. A kite which flew perfectly one day would scarcely rise on another. It would be impossible to give anything like a detailed account of my numerous experiments. I tried a great variety in forms of kites and attachments of string. I have records of twenty-seven different days' experiments in that year, and many of them were devoted to very small details of construction. These experiments were continued the next year, but it really seems extraordinary how little actual progress resulted, so often did one particular idea have to be tried again and again under all conditions before any decided conclusion could be arrived at; and as often as not did I finally conclude that that whole series of experiments was absolutely negative. Yet again and again I had such successful days of work that I was encouraged to continue. Here are some of the designs with which, together with many others, I experimented (see Fig. 1). They all have certain advantageous qualities, but each required endless alterations before really satisfactory results were obtained.

These experiments have continued off and on up to the present, but, as I have said, it would be impossible

for me to detail them all, though carefully recorded, I having up to date records of close upon two hundred different days' experiments. I will, therefore, endeavor to summarize the results which I obtained.

I soon found that the wind force is always so variable from one moment to another that to record its velocity during experiments was hopeless, even though that may seem a necessity in careful scientific experimenting. I proved:

1. That a tail is an unnecessary appendage to a properly constructed kite.

2. That by means of two strings suitably attached a kite can be guided so as to fly well some 45° to each side of the wind course, and under favorable circumstances more.

3. That a kite which is perfectly flat, in very light weather will fly well, but that in strong winds it will be very unsteady.

4. That if it be given much of a "diedral" angle, that is, if the sides of the kite are thrown back like a butterfly's wings, or if it presents a convex surface to the wind, it will not rise to so great an elevation as if flat, but will be steadier in strong winds.

5. That a large kite flies more steadily than a small one.

6. That if the vertical section of a kite presents a concave curve from top to bottom (thus ⌒), the kite will ascend to a certain height and then "top," that is, dive over forward till it lies horizontally on the air, and will then sink to the ground. But that if the form of the kite is such that its section presents two or more curves (thus ⌒⌒) this tendency is prevented.

7. That the angle which the string takes with the horizon is variable, depending on the form of the kite and on the strength and direction of the wind (which sometimes has an upward trend). The most usual forms vary from 30° to 50°.

8. That the weight which a kite can lift will of course depend very greatly on the wind force, but a concave form of kite is more powerful than a convex one. In a light wind about 0·1 pound per square foot of kite may be counted on, in medium winds 0·3 pound, in strong 0·5 pound.

9. That if the weight to be lifted be affixed to the kite, or very close to it, it is very liable to upset the equilibrium of the kite and render it unsteady.

10. That "duplex" lines, that is, two retaining lines fixed apart on the ground and attached to two points, one on each side of the central axis of the kite, enable it to fly with great steadiness in all winds.

11. That in light winds the line may be attached higher up on the kite than in strong winds, and that this raising of the point of attachment causes the kite to rise easier, but to be more unsteady.

12. That a "regulator," or line attached to the lower part of a kite, the pulling of which alters the angle it presents to the wind, causes it to rise or fall as desired.

13. That the pull of the string of a kite may be taken roughly as—in light winds 0·1 pound per square foot, in moderate 0·7 pound, in strong up to 2 pounds per square foot of kite surface.

As for shapes, there are many kinds which fly well if properly adjusted. The following points have to be considered:

1. Lightness, so as to ascend easily in light winds. For some purposes it may be desirable to construct special kites, but these very light ones should never be used in strong winds, else they might become strained or damaged. 2. Stability in strong winds, which quality may also necessitate heavy construction, rendering the kite useless in light airs. 3. Portability. For most purposes, especially when large kites are desirable, it is necessary that they should be easily folded up. 4. Simplicity. The more complicated forms of kites are very liable to damage, and one little detail going wrong may upset the balance and the whole efficiency of the kite. 5. Power to lift or draw. Some forms of kite possessing these qualities may not have so much power as others. Thus a baggy, concave kite is powerful, though perhaps unsteady. 6. Good rise, that is to say, power of attaining a steep angle with its string. 7. Strength, both to withstand the pressure of wind and to stand knocking about while on the ground.

Though not absolutely necessary, a vertical backbone down the center of the kite seems desirable. The crosspieces to hold out the material transversely may be in front of or behind the cover, but what is better still is to have them inclosed in seams in the material.

A difficult question to decide is that of flexibility or rigidity. If the framework of a kite be very flexible, it may in strong winds so bend when struck by a strong squall that it lessens the effective area and thus automatically regulates the pull on the line. This characteristic would appear to be most desirable. I have arranged kites with springs, so as to fold back diedrally when struck by unduly strong puffs; but practically I must own that so far I have not succeeded in devising any very satisfactory arrangement. The same may be said as regards springs applied to the bridle, so as to allow the kite to automatically present a different angle to the wind, according as it is strong or light. In practice, a stiff, rigid kite is generally the most satisfactory, even though the pull on the line may in consequence be as variable as the changes of wind force.

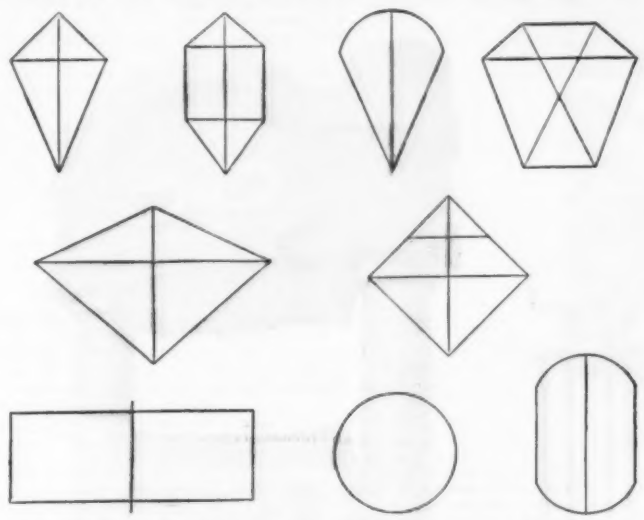


FIG. 1.—SHAPES OF EXPERIMENTAL KITES.

What I have hitherto found to be the best form all round is one nearly hexagonal in outline, stretched on a framework consisting of three poles of equal length, one forming an upright "backbone," the other two placed across it at right angles to form "crosspieces." This form of kite is very simple and portable, as, when the backbone is unshipped, the kite (with its bridle) can be rolled up on the crosspieces. When flying, all the central square forms a powerful concavity, or rather two concavities divided diedrally by the backbone to give steadiness, while the top triangle prevents all tendency to "top." This pattern, for distinction, I have designated "levitor." As regards size, I find the most convenient to be 12 feet high and 12 feet wide. This is about the largest size that can be handled easily. The poles are as long as can be conveniently transported in one piece. Such kites weigh complete from 5 to 7 pounds, according as they are intended for light winds or strong, and have an area of about 110 square feet. I have about fourteen such kites. My largest kite was 36 feet high, containing 500 square feet, but this, though I flew it on some twenty different occasions, I found to be rather unwieldy. I have one 24 feet high which is more convenient. I am still not quite decided whether it is practically best to use one or two large kites, or a number of small ones, for lifting weights such as a man. Small kites are handier—they are lighter for a given area (since very large kites necessitate very large poles), and if one becomes damaged it is more easily replaced, and if an accident occurs to one kite while flying in midair, there is not necessarily a sudden collapse of the whole apparatus. On the other hand, big kites are simpler to make and require but one adjustment. They seem to float more steadily in gusty winds (since they are acted on by a number of variable currents), there is less complication of strings and they are probably more efficient. I have frequently tried an appendage like the rudder of a ship, which has a decidedly steadying effect.

There is one form of kite which calls for special comment. It is known as the "Hargrave" or "box" kite, having been invented by Mr. Hargrave in Australia. I have here a specimen which will more readily convey an idea of its peculiar construction than a long description. You see it is like two boxes with their lids and bottoms knocked out and connected a short distance apart. This kind of kite has found great favor in America, where it has been used for many purposes, including the high ascents for meteorological purposes at the Blue Hill Observatory.

My own experience with such kites is rather limited, but in practice I have found them possess very little advantage over other good forms, and I am unable to comprehend any very special theoretical advantage in them.

Such a form of kite is bound to be heavy, and I will endeavor to show later on the theoretical objections to a heavy kite. The average weight of those used at the Blue Hill Observatory is about 0·1 pound per square foot of sustaining surface. My "levitor" kites (which are of much larger size and should therefore be heavier in proportion) average 0·05 pound per square foot. That is just half the weight for a given area. It is almost bound to be more complicated and difficult to fold up. Being heavier, I have always found a Hargrave more difficult to get up in light winds. In very strong winds, though the Hargrave may perhaps be steadier than any other single line kite, there is no comparing it for steadiness with one on a system of duplex lines. Still, for certain purposes, such as attaining great elevations in strong winds, it may be useful.

As regards retaining lines, I have generally used one of three systems: (1) the usual single line; (2) the "duplex," with the two lines fixed apart so that they join the kite at an angle of about 60°; and (3) the "rein" or steering lines (for small kites) in which the duplex lines are held together in the hand and used like reins for steering the kite.

The first system is employed if it is desirable to get out a great length of line, or for towing, and when steadiness is not a matter of importance; the second, when great steadiness is desired; and the third for steering kites.

In using several kites together, there are several different methods of attaching them, best explained by diagrams.

a. The "duplex" applied to several kites (difficult to apply more than two or three kites.)

b. "Parallel" system, each kite presenting the same angle as the one below it, and thus the whole system is under control.

c. Single line passing through the kites.

d. Single lines, each lower kite having a "back bridle."

e. Independent kites "buoying" the line.

Each of these systems is applicable under certain circumstances, and a combination of one or more is often used.

I have here a specimen of a kite fully fitted. By this system of running thimbles it can be used so as to

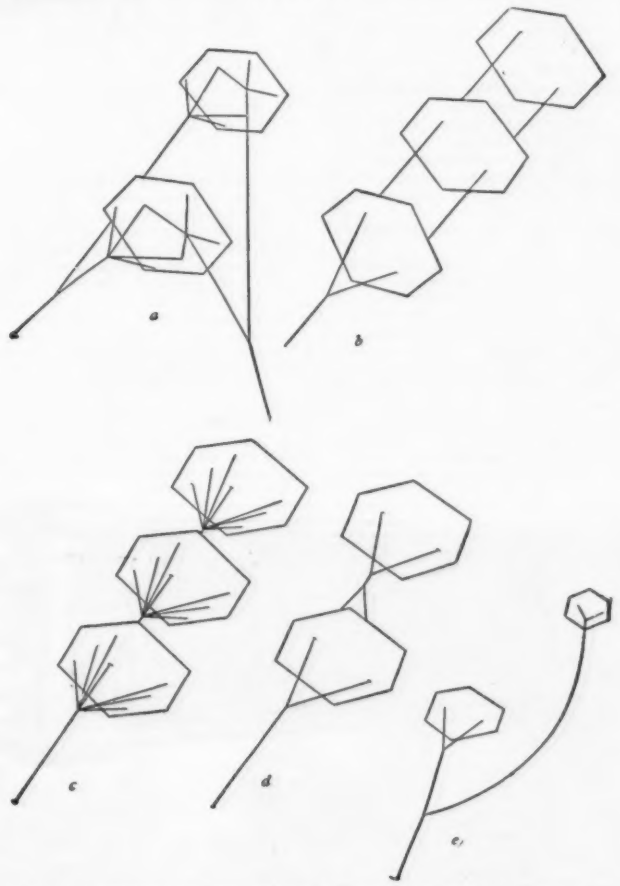


FIG. 2.—METHODS OF CONNECTING SEVERAL KITES.

fly independently on a single line or duplex on two lines.

I also have a model to show what I believe is the best method of suspending the car to lift the man. In this he is perfectly steady. It cannot swing or rotate.

As regards materials, I have found that for the framework of all kites there is nothing like bamboo, though this material may be obtained in many different varieties, some not so suitable as others. I have tried various sorts of wood, but have always been dissatisfied with it. It is generally either too heavy or too brittle. Male bamboo, though very strong, is too heavy or too flexible. The same in an increased degree may be said of steel tubing. The thinnest steel I could obtain is very much heavier than bamboo of somewhat the same diameter, even though it may be stronger. If of much less diameter, it does not possess the requisite rigidity. It is of course also much more expensive.

The cover I have usually made of light cambric, which is very satisfactory, seldom tearing unless through catching in some tree, etc. For very light kites I have tried silk, and also goldbeaters' skin. Paper is a wretched material, even for the roughest models. It is so liable to get torn even before an experiment can be completed with it.

For cordage I have generally used Italian or Russian hemp. Steel wire ought to possess great advantages; but in practice, at all events, for experimental work, its liability to kink, to get rusty, to attract lightning, and its awkwardness to handle, render hemp preferable.

Let me add a word against all metal cliphooks, spring swivels, etc., which I at first used much, but soon found to be unreliable, heavy and generally unsatisfactory. Wooden toggles and eye splicers are much to be preferred.

I might emphasize the fact that these remarks on the materials used in kite construction are derived from my own experience. Careful experimenters in America have come to other conclusions. (Vide Marvin, Millet, Lamson, etc.)

I will now say a few words as regards the practical working of kites.

In very light winds there may be a difficulty in getting a kite up. Then it is best to lay out a long single line along the ground, say 200 or 300 yards long. Let one end be attached to the kite, and a man hold the other end and run with it. The kite will thus rise into the air some 300 or 400 feet, even though it be a dead calm. But often there is a light breeze above which is imperceptible below, and if the kite floats of itself its string may be affixed to a second kite, which it will gradually draw up, and thus a whole series carried up to the upper current.

Even very large kites may be got up in this way. I have several times tried towing such kites with about a dozen men running, or by attaching the kite line to a wagon drawn by horses. By both these methods a man has been lifted.

The subject of the upper currents of the air has been discussed by Mr. Douglas Archibald, who conducted a series of kite experiments which tend to prove that the velocity always increases with altitude, and in the proportion of

$$\frac{V}{v} = \sqrt[4]{\frac{H}{h}}$$

when V and v represent the velocities, and H h the corresponding heights.

In strong winds it is usually best to use duplex lines, the ground end fixed to pegs or to trees, etc., so that the wind blows up between them. In strong winds the retaining line or lines should always be securely fixed before the kites are let up, else it may be impossible to hold them.

As far as practical utility goes, I have used kites for the following purposes:

1. To lift a man similarly to a captive balloon, which may be very useful in military operations as well as for all purposes where a lofty lookout may be desirable. I have actually been lifted on about eighteen different occasions, sometimes going as high as 100 feet (the limit of the perpendicular rope). I have also let up weights, equal to that of a man, 300 feet high; and I believe that the height attainable is chiefly dependent on the length of rope available. The kite area has varied from 300 to 800 square feet. In most cases I have used from three to eight kites, but have also made ascents with one kite of 500 square feet.

2. To lift a torpedo or large charge of explosive to be wafted over a fortification, etc. I have let up some hundreds of pounds weight and sent it off over a place half a mile off.

3. To take up a photographic camera so arranged as to obtain a photograph of the country beneath. I have here some specimens taken.

4. To sail boats, for which purpose kites seem most suitable, as the boat can sail very close to the wind, and with no fear of capsizing.

5. To draw a cart, which may be very useful in open country. It is surprising the amount of power the kites possess even in a light wind.

6. Communication between ships at sea, by which letters and parcels can be conveyed without the necessity of lowering a boat.

Also for signaling, getting ropes to otherwise inaccessible places, and many other purposes.

(To be continued.)

PRESSES FOR BALING COTTON.

WE illustrate herewith two presses for baling raw cotton, constructed by Messrs. Rice & Company, of Leeds, and designed for compressing bales weighing 395 pounds to a thickness of 12 inches. The work is effected in two operations. In the first press the charge of cotton is compressed until its height is reduced to 20 inches, and in the second press the work is completed.

Fig. 1 shows the preparatory apparatus, in which the bale is half pressed. It is represented lying horizontally, while in reality its position is vertical. It consists of three cylinders, of which the pistons are fixed to a movable table rising in a case formed of plates that are strengthened to the right and left by ribs.

Two strong hinged cast iron doors are placed at the upper extremity of the pressing case, immediately beneath the head, and it is through the opening of these that the charge of cotton necessary for forming a bale is introduced. During the compression these doors are closed by means of bolts with handles.

As soon as the water distributing valve is opened the piston table begins to ascend. This valve is so arranged that the hydraulic pressure exerts itself first under the single central piston. During this first period of the operation, the cylinders to the right and left are, in measure as their pistons rise, filled with water from a reservoir.

When it is impossible for the central piston alone to do any further compressing, the valve admits the water under pressure to the lateral cylinders. Beginning with this moment, the three pistons act in concert to compress the cotton. Finally, the bale occupies a space 20 inches in height, while the initial distance between the head and table of the press measures 16 feet.

After this first part of the operation is accomplished, the doors of the press are opened and the unfinished bale is removed by mechanical means. After this, the piston and table descend, and their weight forces the water that fills the cylinders to rise into the reservoir in order to be used a second time.

The prepared bale is next carried to the finishing press (Fig. 2), which is of very strong construction. This is provided with two pistons that act in steel cylinders that furnish a total pressure of 1,500 tons. In this the cotton is compressed until the thickness of the bale is finally reduced to 12 inches.—Revue Industrielle.

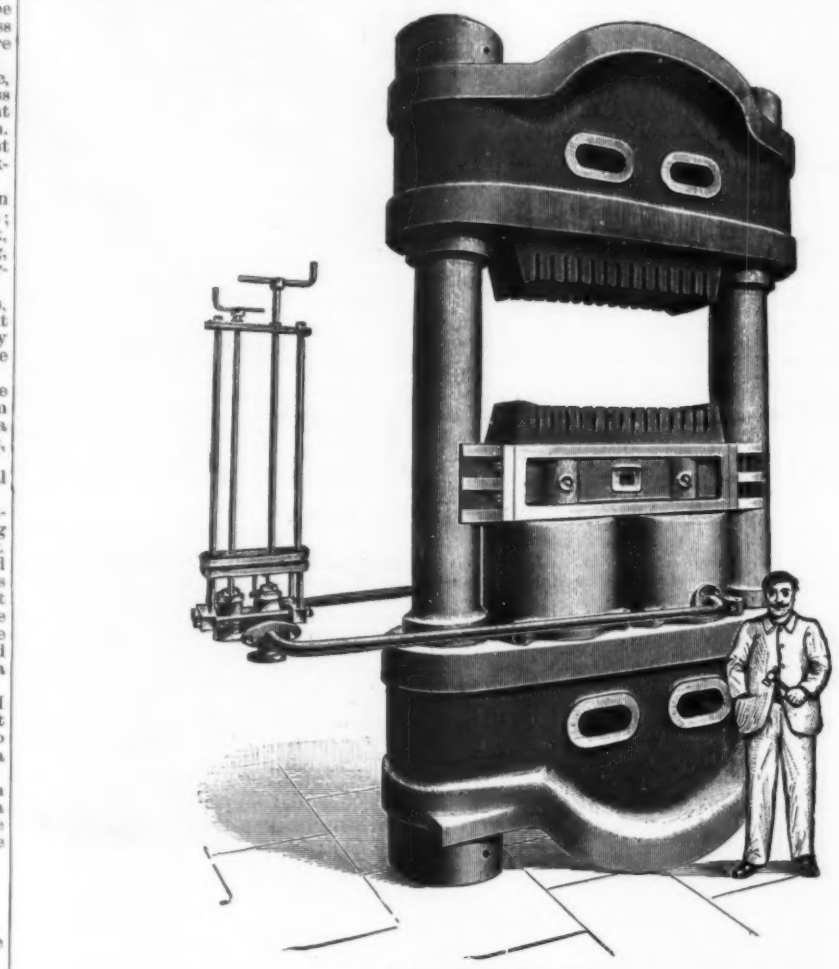


FIG. 2.—FINISHING PRESS.

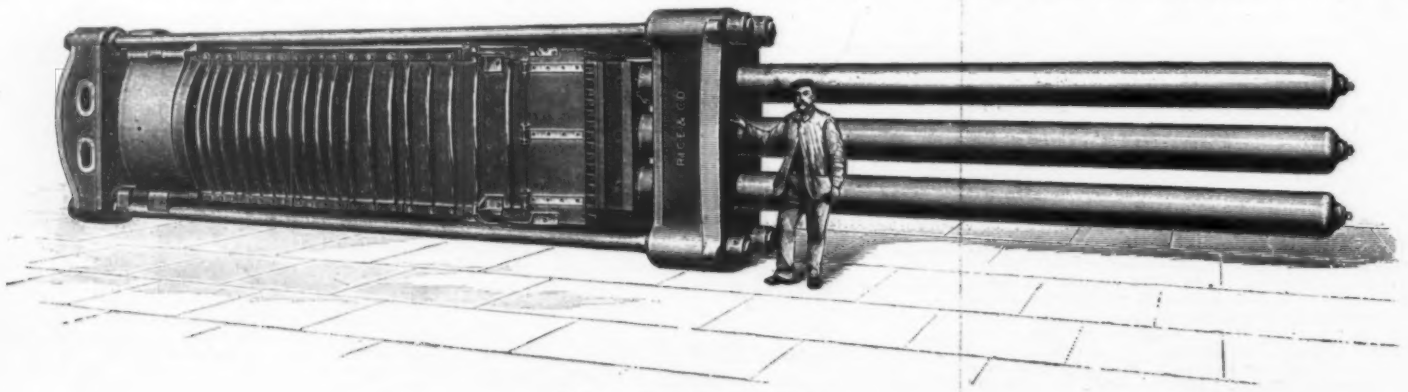


FIG. 1.—PREPARATORY PRESS.

DIRECTIONS FOR WORKING ALUMINUM.

A VERY pretty mottled effect is secured on aluminum goods by first polishing them and then holding them against a soft pine wheel run at a high rate of speed on a lathe. By careful manipulation quite regular forms can thus be obtained. This can be varied by first scratch-brushing or sand-blasting, and then holding the goods against a wheel as previously described. Aluminum which has been sand-blasted receives a grain which will allow of printing on the surface of the sheet with the best results, and aluminum sheets thus prepared are coming very largely into use for photo-lithographic purposes. The surface in such cases is first sand-blasted in order that it will take and retain the ink, and produce very clear and sharp outlines when printed from. The faces for cyclometer dials, watch dials and similar articles are generally sand-blasted before they are printed upon, which gives a very fine white background.

Directions for Dipping and Frosting.—Remove the grease and dirt from the plates by dipping in benzine.

To whiten the metal and produce a handsome frosted surface, the sheet should be first dipped in a strong solution of caustic soda or potash; then in a solution of undiluted nitric acid; then washed thoroughly in water, and dried in hot sawdust. The sawdust must be of a fine, dry grade, with no resin or pitch that will streak the surface.

For Burnishing.—Use a bloodstone or steel burnisher. For hand-burnishing, use either a mixture of vaseline and kerosene oil, or a solution composed of two tablespoonfuls of ground borax, dissolved in about a quart of hot water, with the addition of a few drops of ammonia.

Lubricant.—The best lubricant to use on aluminum when being turned in the lathe is either kerosene or water; and in the press, when the metal is being drawn or stamped, vaseline.

Tooling.—The best results in working aluminum can be derived by using a "shearing tool," or, in other words, a tool which is shaped more resembling one used in working wood than for working iron or brass, thus securing a tool with a sharp point, which gives the metal an opportunity to free itself, rather than clog the cutting edge. Tools of all descriptions can be made on this principle, regardless of the purpose for which they are intended, whether to cut a thread or turn to a surface.

Benzine is considered the best lubricant on engravers' tools to obtain a bright cut on aluminum, although naphtha, kerosene, or a mixture of coal oil and vaseline is sometimes used. The benzine is preferred, owing to the fact that it does not destroy the satin finish in the neighborhood of the cut, as the other mixtures will sometimes do, if they are not carefully handled. There is, however, as much skill required in using and making a tool for a bright cut as in the choice of the lubricant that is used.—Aluminum World.

TRIPLE-GEARED SLIDING, SURFACING, AND SCREW-CUTTING LATHE.

WE illustrate herewith a powerful lathe constructed by Messrs. Sharp, Stewart & Company, of the Atlas Works, Springburn, Glasgow, for turning crank and propeller shafts as well as for general work. The lathe can be run either single, double, or triple geared, the driving in each case being effected by a pinion at the back of the face plate, so that the spindle is relieved from all torsion. This spindle, it should be added, is 10 inches in diameter, running in capped bearings of gun metal, and carries a five-stepped belt cone, as shown, the steps being wide enough to take a 6¼ inch belt. The face plate is arranged to act as a massive four-jaw chuck. The bed, it will be seen, is extra long, the lathe being capable of taking pieces 30 feet in length between its centers.

There are, it will be seen, two saddles at the front of the lathe, each fitted with a compound slide rest, having a swiveling motion for taper work. These slides can be removed at will, a narrow rest being substituted when operating on crank work. At the back of the lathe two other saddles are provided, which are fitted with special compound slide rests for dealing with crank webs. The front and back saddles are operated independently by steel guide screws, driven by independent sets of change wheels, at the back and front of the lathe respectively. The inward feed for all the rests is obtained from longitudinal side shafts and change wheels. Quick disengaging motions are supplied to all the feeds. The spindle for the loose headstock is fitted with a worm and handwheel.

To secure rigidity the bed is of the box section, and is double, the sliding surfaces for the back and the front rests being quite independent of each other. The centers are 3 feet high, and the face plate 6 feet in diameter, while the weight of the tool complete is about 50 tons. We are indebted to London Engineering for the cuts and particulars.

A NEW STYLE OF BICYCLE PEDAL.

THE style of pedal which we are about to describe bears no relation to the numerous mechanisms that have already been devised. The bicycle, in fact, is identified with the invention of the Michaux loose pedal, while it is a question here of a fast one.

The crank here is replaced by a jointed quadrilateral (Fig. 1). The pedal properly so called (which has the form of a triangular frame provided with a curved toe piece) and one of the sides of the quadrilateral (the opposite side of which is fixed to the sprocket) are interdependent. The only condition that this quadrilateral must fulfill is that the sum of the fixed side of the pedal and of the adjacent side that ends at the sprocket shall be smaller than the sum and greater than the difference of the two other sides. This very simple system possesses various mechanical properties that we shall recapitulate.

Cinematic Properties.—Let us give the side of the quadrilateral comprised between the side, a, and the sprocket the length, R, of the ordinary crank. If, during the revolution, the foot remains parallel with any direction whatever, but fixed (Fig. 2), the point, A, will describe a circle of the radius, R, the center of which, instead of coinciding with that of the sprocket, as in the ordinary crank, will be at a distance, a, from the latter, in a direction parallel with that of the foot. In Fig. 2 we have supposed that the foot remains horizontal. The center of the sprocket is at the point, O', distant by a from the center, O, of the circle described by A. If, during the revolution, the foot assumes variable inclinations (and this is the case in practice), the point, A, will describe a sort of ellipse without precise definition. Thus the foot is free to cause the position and the form of its trajectory to vary within certain limits.

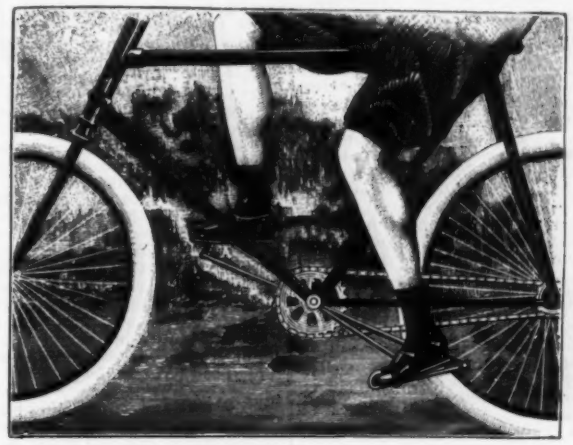


FIG. 1.—A NEW BICYCLE PEDAL.

On another hand, the velocity of the point, A, will vary constantly during each revolution, because, since one of the feet describes the portion of the trajectory situated to the left of $\alpha O' \alpha'$, the other will describe the shorter portion situated to the right.

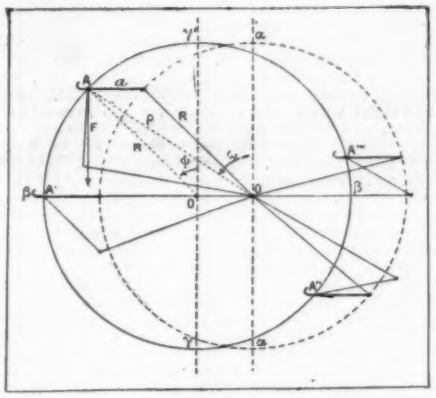


FIG. 2.—DIAGRAM EXPLANATORY OF THE OPERATION OF THE PEDAL.

Thanks to these two cinematic properties, the foot, instead of being confined to a uniform revolution (which in reality is not a natural motion), is capable of taking on a gait which appears better from a physiological standpoint, and which is very similar to that of walking or rather to the step of gymnastics.

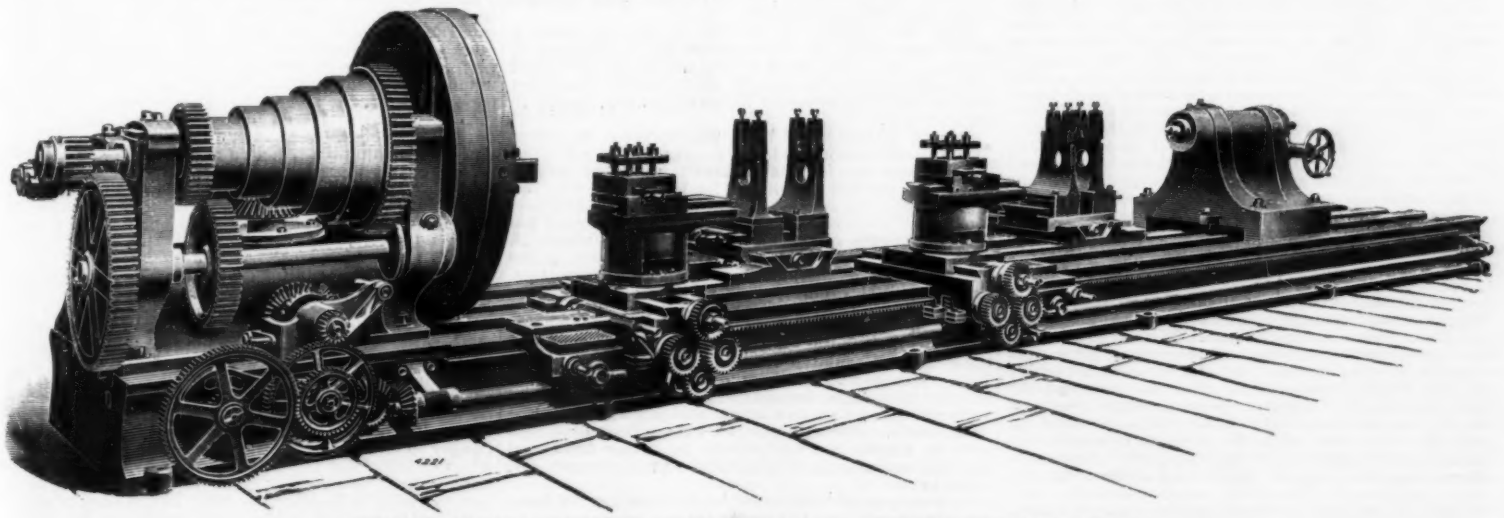
Dynamic Properties.—Let us suppose that the point, A (Fig. 2), be that of the application of a constant vertical force, F, and let us see how such force will act respectively with each of the two systems of pedal when A displaces itself between γ' and β. Let us consider the case of the ordinary pedal. The center of the sprocket coincides with the center, O, of the circle described by A. The force, F, is decomposed into two others, one of which, at right angles with the crank, O A, furnishes the useful work, while the other, following the direction, O A, is destroyed by the rigidity of the rod.

On another hand, let us consider the jointed pedal as having the point, O', as the center of the sprocket. Let us again decompose F into two forces, one of which, at right angles with the diagonal O'A of the quadrilateral, furnishes the useful work, and the other, directed according to A O', tends to shorten such diagonal. In order to make the point, A, describe the same circle as before, it is necessary, on the contrary, to elongate it, and, to this effect, to keep the pedal parallel with O O'. The production of the effective work therefore requires here the simultaneous production of an auxiliary work of the joint of the foot. But such work acts indirectly as a motive one, since a very simple calculation demonstrates that the motive work produced with the jointed crank is equal to that which would have been produced with the loose pedal increased by the auxiliary work. Now, the foot exerts the stress that produces this latter work, under the form of a couple applied to the lever which is constituted by the pedal. Moreover, such stress results from a normal and instinctive motion. Finally, if we remark that with the ordinary crank the foot bears at the apex and that the stress is transmitted through the ankle, it may be said that in both cases the joint of the foot is submitted to a fatigue, but that, with the jointed crank, the stress of the feet, without a notable increase of such fatigue, is totally utilized as motive work.

The motive work produced with the jointed crank depends upon the relation $\frac{a}{R}$. The value $\frac{a}{R} = \frac{1}{3}$ appears to be the most fitting in practice. Calculation shows that it corresponds to an increase of motive work of the ordinary pedal, greater than a sixth thereof. Such theoretical value is a minimum. In the first place, no account has been taken in the calculation of the fact that in the regions $\alpha O' \gamma$ and $\alpha' O' \gamma'$, in which the force, F, cannot act, the joint of the foot furnishes a stress which, while suppressing dead points, increases the effective work through strokes of the pedal. Moreover, in order to facilitate the reasoning, we have supposed the force, F, to be constant and vertical; but this hypothesis, which is not realized in practice, is more unfavorable to the jointed than to the loose pedal. In fact, in practice, we instinctively cause the thrust to vary in order to improve its rendering. Now, during the effective part of the travel, the variations in the inclinations of the foot, which improve the rendering with the loose pedal, are those which, with the jointed pedal, simultaneously elongate the arm of the lever. The rendering is thus improved for two reasons.

Conclusion.—Upon the whole, the fixed pedal permits of increasing the motive power in converting the normal motions of the joint of the foot into useful work, and of describing with the most natural gait the trajectory which at every instant is most favorable to a proper utilization of the thrust.

The first trial of this new pedal appeared to confirm its advantages, but precise and continuous experiments



TRIPLE-GEARED SLIDING, SURFACING AND SCREW-CUTTING LATHE.

would alone be capable of making known its true practical value. However this may be, it results from the study of this mechanism that all its properties are due exclusively to the fact that it constitutes a system of incomplete connections.—La Nature.

AN ELECTRICAL BUREAU.*

MR. PRESIDENT and Gentlemen of the National Association of Commissioners and Inspectors of Buildings, of the United States of America:

The topic assigned to me by your president, viz., "Should cities with a population of 75,000 and over organize and maintain an efficient electrical bureau to supervise new and old insulations of electric wires, motors and generators, for the better protection of life and property?" is one of great importance, and one that gives me a great deal of pleasure to prepare and present for your consideration; but I have taken the liberty to give it a somewhat wider scope than its title would indicate, because, while the insulation of wires, motors and generators is an important feature in the transmission of electrical energy of high potential, there are other matters of equal importance to be considered by those who have charge of municipal electrical bureaus, and in whose hands rest in a great measure the lives and property of the people.

To the question propounded in the title of this topic there can be but one answer, viz., Yes; and I trust I shall be able to demonstrate to the satisfaction of all thinking men the correctness of my position.

The first question that might be asked those desiring the establishment of an electrical bureau would naturally be, What is the need of it? To such a question I will try to make answer in my own way, and I hope to the satisfaction of my hearers.

It is not my purpose to needlessly alarm you or others by magnifying the dangers that attend the transmission of electrical currents of high potential or pressure, but to show that when such dangers do exist it is due mainly to the culpable negligence, ignorance or dishonesty of some one. Unfortunately for the safety and welfare of the people who use electric energy for the production of heat, light or power, and the citizens at large as well, there are three causes that militate against the safe transmission of electrical energy. First, the keen competition between those engaged in installing electric conductors and appliances; and second, the desire of their customers to obtain labor and materials at the lowest figure, regardless of the character or ability of those to whom they intrust this most important work, and their entire obliviousness to the dangers their families, themselves and their property are liable to be exposed to, owing to poor or careless workmanship and the use of poor material.

There is no subject of which the public so persistently remain in such blissful ignorance as that of electricity; and there is no field in which the cheap John, endowed with an unlimited amount of cheek, a glib tongue and a perfect vacuum where his conscience should be, as the electrical.

There are various types of persons engaged in the electrical construction business, not mentioning the so-called electricians who spring up everywhere like mosquitoes in a rain water barrel, and who know as little about electrical science as a Hottentot knows about the ten commandments, or a police court pettifogger about international law. Many of these so-called electricians assume that title after having spent a few weeks in fastening up telephone, bell or gas lighting wires. To them insulation is but a name, and volts, amperes, ohms and watts are unknown quantities; yet to such as these do men intrust the important task of installing wires and appliances for the transmission of electrical energy, which must have a smooth and easy path provided for it, one from which it cannot wander and cause loss of life and property.

Many of the reputable contractors will not willingly tempt fate by undertaking to do work and use materials that they have reason to believe will result in serious loss, trouble and possible personal injury; but there are those who do not scruple to do so for personal gain, and they are enabled to do it owing to the inexperience of the average man in electrical matters.

The insulating covering of the conductors may be but a film; the wire itself too small for safety or efficiency; the switches mechanical and electrical abortions, but efficient tools in the hands of would-be incendiaries (did they know it), and every controlling device having but one merit—cheapness—to commend them to the would-be purchasers, all such things being alike to them, a wire of 90 per cent. conductivity being the same as that of 99 per cent., switches, cutouts, etc., of the most flimsy character being accepted as readily as the most approved material and devices, provided the former costs the least.

I will now sketch briefly some of the forms of useful work performed by the electric current. Its first commercial application in this country was in the transmission of intelligence over wires from one point to another by means of printed characters known as the Morse alphabet, registered on a moving slip of paper by means of electrical impulses sent over the wires, the current or energy being produced by the chemical decomposition of zinc in what was known as the galvanic battery. The electrical energy thus produced was very limited, incapable of injuring persons or causing fire.

The outside wires were of iron, not covered with insulating material, but supported or suspended on insulating substances. The wires on the interior of buildings were covered with cotton and they were fastened in the most convenient way to walls or ceilings, or placed between partitions or in the space between floor and ceiling; no attempt was made to support them on insulators or cleats. More or less trouble was experienced where the cotton-covered wires were exposed to the weather in the space intervening between the terminals of the iron line wire and the instruments, also where excessive moisture prevailed within the buildings containing them. Various expedients were resorted to in order to overcome this defect, until the process of insulating such wires with a covering the basis of which was rubber was discovered. The cotton covering was subsequently treated with paraffine to prevent the absorption of moisture and improve its insulating qualities.

This method of installing interior wires used for the transmission of electrical energy for commercial, fire and police telegraphs, burglar and automatic fire alarm systems, electric call bells and telephone systems, is in use at the present time, and answers for that purpose very well, for while failure of the insulation of such wires will cause an interruption of the service, it will not cause injury to person or property.

The task of installing wires for the transmission of electric currents over telegraph, telephone, fire and police signal, burglar alarm, automatic fire circuits, etc., is very simple. Not so however with electric light, heat and power circuits. To properly install such requires a special training, a fair knowledge of the laws of the electric current, the ability to make the necessary computations, and a full realization of the serious consequences that might result from improperly installed wires and fixtures.

Gas, steam and water can be distributed through streets and buildings without serious difficulty, because pipes and fittings are of sufficient strength to withstand the strain put upon them and the ravages of time as well. It is only necessary for the gas, steam or hydraulic engineer to determine the proper size of pipe to deliver a given amount of gas, steam or water; its mechanical strength and lasting qualities have been determined in advance, and when it is properly connected and placed in position it need not be a continued source of anxiety.

The electrical engineer has entirely different conditions to contend with when he seeks to transmit electrical energy from one point to another. Electricity, unlike steam, gas and water, is not conveyed through pipes or tubes that hold it securely until it reaches its destination, but, on the contrary, is conveyed over solid conductors, reliance being placed on various insulating compounds to keep it from straying away from the true path, thus avoiding the work assigned to it and possibly causing more or less damage to persons or property.

The useful life of the best of these insulating compounds is limited, and under certain conditions is very short indeed. Some of them contain the elements of their own destruction, while others are quickly affected by gases, changes of temperature and other causes. Underground conductors designed for high potential circuits must be covered with a high grade of insulation, and that in turn protected from the action of the elements by an outer covering (usually of lead). These outer coverings are what really make it possible to maintain and operate high potential circuits under the surface of the streets of the cities and towns where such construction is insisted on.

When the first attempt was made to introduce the electric light commercially, there were two things of very great importance that were lacking, viz., electrical engineering skill and proper material. When the arc light was made possible by the invention of the dynamo electric machine, which produced a current of from 10 to 20 amperes with an electromotive force at first of 50 volts, no one knew the best method of conveying it from the dynamo to the lamp. At first the same method adopted by the telegraph engineers was tried, and so long as but one lamp was placed on a circuit this plan worked very well. But when it became possible to place several arc lamps in series on one circuit the troubles of the electrical engineer, electric light promoters, insurance companies and property owners really began. With a five light machine requiring five horse power to produce the necessary electric energy, the cotton covering impregnated with paraffine was often ignited, first, because the wire was too small, and often due to the excessive heat generated at the connections, which, as a rule, were poorly made and of insufficient capacity. This led to the practice (not long indulged in, however) of using wire without any covering at all. It was soon found that this plan would not work, and it was abandoned. The point aimed at then was to produce a covering for wires that would not ignite readily, and this led to the production of the so-called "underwriters covering," which consisted of two or three braids of cotton impregnated with zinc paint. For a number of years this was the only insulated wire used for the electric lighting circuits that spread rapidly over our streets and into our buildings; it was usually supported on glass insulators and hard rubber hooks when out of doors, and fastened under wooden cleats when in the buildings.

Outside circuits were run without much system or regularity; poles in the streets, bridge and corner irons and wooden structures on buildings served as supports for these wires. The insulation was the well-known "underwriters," which served fairly well so long as it was dry, but when rain storms set in it ceased to be an insulator, as the current went through it like water through a sieve.

With the increase in the size of the dynamos a better insulation for wires placed in the interior of buildings was called for, and now nothing is permitted by insurance and municipal inspection bureaus but rubber insulating covering for interior work, except in special cases.

Rubber unprotected by a weatherproof covering, such as lead, is soon rendered useless by the action of the elements, and for that reason is not used to any extent for outside circuits. "Underwriters" wire has been largely displaced by what is known as weatherproof wire, the covering of which is cotton braid impregnated with a bituminous compound, which in course of time evaporates and leaves the cotton as the only bar to the escape of the current to the earth, trees, lightning rods, other electric wires, animals and the human body. It is safe to say that the average circuit consisting of weatherproof or "underwriters" wire offers but little more resistance to the escape of current than does uninsulated iron telegraph and telephone wire. Woe be unto the man or woman who, depending on the so-called insulation, grasps a high potential wire while standing on a brick wall, a tin roof or the moist earth. One who does so by accident or design will be apt to lose all interest in things terrestrial and become an object of interest to the coroner and undertaker.

I sometimes think it would be much better to hang out the danger signal at once and use no so-called insulating covering on any high potential wires, and publish broadcast the fact that to touch or handle meant death or serious injury.

Since the first commercial arc light was produced the capacity of the dynamo has increased from one light to five, ten, fifteen, twenty-five, thirty, forty-five, fifty and sixty-five. One light meant a pressure of electromotive force of fifty volts, attendant with no danger to life or limb. A sixty-five light circuit means a pressure of 3,250 volts, or more than sixty-five horse power. I need not say to you that if this energy were concentrated at one point, and that point the human body, that it would soon become a piece of inanimate clay; or if it were concentrated in the form of heat at one or more points, the services of the fire department would be required; and were not this electrical energy stopped in its career, the difficulty of subduing the flames would be greatly increased, and possibly a hearse become a necessary adjunct to the equipment of the fire department. The sixty-five arc light machine is no longer the maximum size, as 125 light dynamos are now quite generally in use, and those of double that capacity are now being constructed. These should call for a better line insulation, but no move has yet been made to secure that very much desired end. Such being the case, the danger from overhead wires attached to this class of dynamos is very much increased.

I have thus far given most attention to arc light dynamos and circuits where the lamps are in series, the current or energy passing through each lamp successively, because this was the first commercial form of electric light; after which came the incandescent system of lighting, where, instead of the exposed carbon with an arc between the points, we have the continuous carbon filament inclosed in a glass globe, from which the air has been exhausted and the carbon brought to a state of incandescence due to its high resistance. In this system the current is subdivided, each lamp taking a small portion thereof, the electromotive force ranging from 50 to 220 volts, from which injurious shocks cannot be received; but the danger from fire is as great from this as from the arc system when the wires are not properly installed. The distribution of current is similar to the distribution of gas, a large quantity flowing through the feeders and mains, and these being tapped at intervals where light or power is to be furnished. The current in an arc light or other high potential system may be likened to a small stream rushing madly down the mountain side, small in volume, but moving at great velocity; while that in the direct incandescent system, where the current is taken direct from the dynamos to the lamps, may be likened to a large river, where the water moves along slowly and in large volume; the power of each for doing useful work being practically the same when properly harnessed.

The size of electrical conductors being in proportion to the pressure maintained and the amount of current delivered, the distance from the source of supply at which current could be delivered for producing light, heat or power was limited, and beyond that limit, it is not possible to deliver current for any purpose at a profit and at a reasonable price to the consumer; so that, while the arc light could be furnished at any point within a radius of from one to three or four miles, the delivery of current for direct incandescent lighting was limited to about one-half mile from the source of supply.

This led to the production of what is known as the induction or transformer system, wherein a pressure of one or two thousand volts is maintained in the conductors connected directly to the generators in order to reduce their size and weight. The feeders and mains are run in parallel, and at all points where current is to be delivered connection is made to transformers that contain induction coils. The current that traverses the primary conductors that lead from the dynamos does not flow continually in one direction, but changes its course several hundred times per minute, in order to induce a secondary current of low potential to supply the lamps. These transformers are placed as near as possible to the point where light is to be produced and in the most convenient place. They are familar objects to most people, and particularly to firemen; they may be seen on poles in the street fixtures, on housetops, walls and roofs of buildings always, and sometimes in the interior of buildings.

Of all known methods of distributing electrical energy, this is the one that should be surrounded with all known possible safeguards. The attempt at insulating the primary wires of this system when overhead and exposed to the elements are simply farcical, as there are no such wires to-day that are insulated by any covering that may be placed thereon. For this reason they should be kept beyond the reach and touch of any one, and free from contact with all other electrical conductors.

Electric motors followed in the wake of the incandescent light, and gradually they began to displace the small steam engine for nearly every purpose, so that millions of electrical horse power are now in use in the performance of work of various kinds. The power of mountain streams and lakes in out of the way places is now utilized, the mechanical energy being converted into electrical and transmitted long distances over bare conductors to where it can be utilized to advantage in furnishing light, heat and power. The pressure in these long distance transmission circuits is from 5,000 to 20,000 volts, this being reduced by means of step-down transformers to the working pressure required, and the alternating current changed to direct when necessary. This is the case at Niagara Falls, where the immense water power is converted into light, heat and power, for propelling street cars in Buffalo and Niagara Falls, and for heating furnaces for the reduction of the most refractory metals.

Owing to the almost total absence of the insulation of overhead electric wires and conductors, the necessity for the greatest possible care in installing wires and conductors in the interior of buildings is greatly increased. A failure in the insulation in any portion of the building whereby electrical connection is made to the earth necessarily increases the fire hazard and danger to life. In the case of incandescent lighting wires or wires for the supply of electric motors the danger from fire is very great, and that is the only danger really to be apprehended. In the case of wires used for the purpose of supplying current to arc lights in series connected to a generator, the capacity of

* Address delivered by William Brophy, before the International Association of Commissioners and Inspectors of Buildings, held at Detroit, Mich., September, 1897, and published in Architecture and Building.

which is sixty-five lights or over, there is an added danger to life.

Could it be possible to thoroughly insulate overhead wires in the same manner as those that are placed underground, this hazard in the interior of buildings would be greatly reduced. On account of this lack of insulation of overhead wires, your duties and the duties of electrical inspectors are greatly increased, as are your responsibilities also. On no account should poor material, poor appliances or faulty workmanship be allowed on any electric wires or appliances within the interior of any building that is used for a dwelling or business purposes.

I now come to the necessity for strict supervision of electrical installations for the production and distribution of electrical energy, having pointed out some of the dangers, inherent and otherwise, to be apprehended therefrom.

In every city may be found commercial, fire and police wires, telephone, district messenger, burglar and automatic fire alarm, electric time, and various wires for signaling purposes too numerous to mention, all of which may be classed as low tension wires and conveying currents that are harmless in themselves. Then come electric light, heat, power and street railway wires; all of these are striving for a place in our streets and on our housetops, often with little regard for the rights, privileges or safety of others. The average members of city councils, individually or collectively, know little or nothing about the transmission of electricity or the proper method of locating poles and wires in the streets and highways, and as a result we have in most of our cities methods of construction that bear evidence of the careful attention and the deep interest taken in favored constituents or corporations seeking valuable franchises, but little or no evidence of any care for the safety of the public at large, or the rules and practices that govern safe electrical construction. Much of this class of work gives ample evidence of the utter incompetency of local government when called upon to act as electrical experts in matters of electrical construction. Before granting any rights to erect poles or wires in the streets, these bodies should consult the head of their electrical bureau, if they have one (as they should), and if not, some other competent authority, in order to reduce the hazard to life and property; when this is done, much of the work that invites disaster will disappear.

I will now enumerate some of the objectionable features that are met and as far as possible corrected by the wire department of the city of Boston, as an example, first taking the outside poles, wires and fixtures.

Many of our streets are encumbered with from one to four lines of poles, owned and occupied by as many different corporations, the privilege to locate the same being granted by the board of aldermen. These poles support electric light, power, street railway, telegraph, telephone, fire and police, and miscellaneous wires, many of which are only an obstruction to the fire department, the currents transmitted over them being harmless; but during some of our New England snow and sleet storms these are broken and, falling as they do on high tension wires, become equally as dangerous and more so, as they cause fires to break out at many points, and worst of all, become death-dealing agents for the time being to firemen or others who might come in contact with them. One of the worst fires the fire department of Boston has had to deal with occurred on Thanksgiving Day, 1889, causing the loss of several buildings, some of which were of so-called fireproof construction, and, worst of all, the loss of several human lives. The cause, as far as can be ascertained, was the crossing of an electric time wire with an electric power wire, there being sufficient current to ignite the fine wire on the magnet of one of the clocks in the building in which the fire originated, and that in turn the woodwork near it; the insulation on all the magnets of the circuit being burned in a similar manner, but owing to the presence of some one at each place where they were located, the fires were discovered and extinguished without damage.

The business portion of Boston is celebrated for its narrow and crooked streets, lanes and alleys. Owing to their condition, it is impossible to erect poles therein for the support of electric wires, and as a result the roofs of buildings have been covered with wooden structures, large and of every conceivable form, which were covered with a vast network of wires that was fearful to contemplate. These wires were run without system or plan, their height varying from one foot to twenty or more above the roofs. High and low tension, insulated and uninsulated wires were indiscriminately mixed regardless of the dangers that might result from this reckless style of construction. Tons of dead or abandoned wire were stretched on poles and fixtures to come within reach of persons when crossed with dangerous wires and obstruct and maim firemen; the miles of this stuff, disowned and neglected by those who placed the same in position, was left to rot and rust because it was not worth the cost of removal, and no moral sense of the obligation due the public would prompt the original owners to care for it.

The condition of the wires, lamps and fixtures within the walls and buildings was much better than that of those outside, owing to the commendable efforts of the fire underwriters. Notwithstanding this the standard of interior electric wiring was far from what it should be, and very little of the work done previous to the organization of the wire department came up to the standard established and now enforced by it.

Contractors, owners, architects, were at first disposed to ignore this department, but they all very soon learned that its requirements were not to be considered as a dead letter, but would be enforced justly and with a firm hand. To the credit of most of those engaged in the electrical business, either as managers of lighting and street railway companies or contractors, they co-operated with the commissioner of wires as soon as they realized that the department was organized for business and not for the purpose of furnishing comfortable positions for the friends of influential politicians. I regret, however, to say that there are in Boston, as in other cities, those who require the watchful care and attention of the wire department to restrain them from doing work and using material that is a positive injury to the business, a menace to life and property, and is sure to increase the labors of the fire department. Architects, without an exception, recognize the value of this department, and when the interests of the public run counter to the views of these gentlemen they gracefully yield to its contention that the public safety is of more importance than æsthetic tastes or any other considerations; contracts and specifications for all classes of electrical work contain a clause that before being accepted all work and material must be approved by the wire department.

The act of 1894 creating this department decreed that all overhead electric wires within a prescribed district should be placed underground, and on this department was imposed the task of enforcing this and all other provisions of this act. The manner of constructing the underground conduits, material used, the kind of conductors and the standard of insulation, are prescribed by the commissioner of wires. All the work as it progresses is supervised at every stage by this department. I am now happy to state that up to date the underground system has proved a success and a great source of satisfaction to the companies owning and operating it.

As an evidence of the great interest taken in our work I will state that the mail brings us letters, the writers of which seek information and advice on nearly every electrical subject. A great deal of time is consumed in replying to these innumerable inquiries.

Having established the fact that a municipal bureau of this character is entitled to an existence at least, I will now endeavor to outline how it should be organized and maintained.

It is said that some time in the dim past "the office sought the man;" later it was said "the office should seek the man." I can safely say that offices with honor and lucrative salaries attached thereto have never as a rule in recent times worn out much shoe leather or become weary and footsore in "seeking the man," but, on the contrary, the men of high and low degree that present themselves as candidates for every office, whether vacant or not, are far more numerous than those seeking grace at a Methodist camp meeting.

When honorable gentlemen make the transparent announcement that they have been "earnestly requested" to become candidates for various offices and finally with great reluctance place themselves in the hands of their friends, it can be safely assumed that such announcements are made for effect on that portion of the public who are not within the fold of practical politicians. The latter named gentlemen know quite well that they have been seen by the candidates, and that the necessary trades and deals as to who should fill the various positions from presidents of councils to janitors of school houses have been agreed to. When candidates for mayors, aldermen and councilmen make their ante-election promises to give various positions to the political workers, too often without the slightest regard to the necessary qualifications of the prospective officials, let them bear in mind the fact that the head and employes of the municipal electrical inspection bureaus must be exceptions to the rule that "to the victor belong the spoils." The fact that a man can arouse enthusiasm by his eloquence, get a large vote out and contribute in various ways to a successful campaign, does not alone qualify him to be the head of such a bureau. The men who pack caucuses, carry torches and shout themselves hoarse in the interest of the winning candidate should not be employed in this bureau as a reward for this kind of labor (perhaps the only kind they were ever guilty of performing) alone in the absence of other necessary qualifications. The honorable gentleman who has been elevated to the position of chief executive of the city, having filled every position with active workers and camp followers in the late campaign, and still having a large number whose only ambition is to get their names on some one of the city's payrolls on his hands, must not cast his eyes on this bureau and convert it into a graveyard for this kind of political drift and deadwood. If this army of patriots (?) must be provided for, it would be far better to provide a special appropriation for their care and sustenance and maintain them in their natural state of idleness than to turn them loose on those engaged in the electrical business and the public, and thus engender profound contempt in the breasts of all for this all-important branch of the public service.

In large cities the head of this bureau should be selected for his known executive ability, and if in connection with this quality he is an eminent electrical engineer, so much the better. He should be permitted to select his own assistants and subordinates, and if he is the right man in the right place, he will see to it that none but those who are well qualified for their positions will be employed. He must not be compelled to appoint ward heelers, political bums or bar room spouters to positions in the bureau where the most laborious duty would be the drawing of their weekly salaries, to please or placate an honorable member of the city council, State legislature or ward, State or city committees.

In the small cities an electrical engineer of good executive ability should be selected for the head of such a bureau. The character of these men for honesty and integrity must be above reproach.

When these bureaus are established on the above plan fewer lives will be lost and less property destroyed by causes that are preventable, due not to the transmission of electrical energy, but the culpable ignorance, cupidity or dishonesty of those who are a disgrace to the electrical business.

LIQUID AIR AS AN ANALYTIC AGENT.*

PROF. DEWAR, at the outset, called attention to the increased importance of the study of low temperatures. He had only that morning received a circular from the Society of Chemical Industry, New York, respecting the liquefaction of air on a commercial scale. The statement had been made that our American cousins purvey liquid air in milk cans. The professor's assistants, Mr. Lennox and Mr. Heath, were determined not to be beaten, and they had, therefore, prepared for his use that evening some two and a half gallons of liquid air. That was contained in a vessel cased in wood, and having the outward appearance of a common milk can, and doubtless surrounded by a vacuum chamber, which Prof. Dewar's researches have shown to be so efficient in hindering the conduction of heat. In order to demonstrate some of the properties of liquid air, a portion was baled out by means of an ordinary measure as used by milkmen, and poured on a silver vessel heated to redness. The liquid remained apparently as quiescent at this high temperature as in cooler vessels, and maintained a spheroidal condition, just as would a drop of water on a red-hot plate. The temperature of the liquid air itself was about —210° C., or 63° in terms of absolute temperature; therefore the red-hot vessel was 10 or 12 times the absolute temperature of the liquid. Prof. Dewar then proceeded to refer to various analytical operations in which liquid air is of service, dealing at length with the qualitative separation of mixtures of gases. Coal gas, a mixture of hydrogen, marsh gas, carbonic oxide, and various illuminating gases and impurities, might be placed in a vessel and surrounded by boiling liquid air. It was possible, in these circumstances, to condense all gases except carbonic oxide and hydrogen, and thus leave a mixture of these two gases.

Ultimately, however, the carbonic oxide might be condensed and hydrogen be left alone in the gaseous state. Similarly, any gas less easily condensed than air could be separated from a mixture of the same with air. Hydrogen present in air to the extent of one in a thousand is just detectable by this plan of work, but smaller quantities are missed, since traces dissolve in the liquid. In order to press this inquiry a little further, some natural gas known to contain a different constituent, like helium, suggested itself as being worthy of trial. Lord Rayleigh's analysis of the gas from the King's Well, at Bath, gave 1·2 parts of helium per 1,000 volumes, so that it seemed admirably adapted for such experiments. By the kind permission of the corporation of Bath, the lecturer had obtained an abundant supply of this gas. Prof. Dewar next threw on the screen photographs of the old Roman Bath and the King's Well. Reference was made to a paper read before the Royal Society on December 19, 1833, by Dr. Daubeny, professor of chemistry at Oxford University, on the "Quantity and Quality of the Thermal Springs of the King's Well, in the City of Bath." Dr. Daubeny's experiments extended over a month, and he estimated the volume of gas given off as from 80 to 530 cubic inches per minute (average 264). Prof. Williamson, of University College, had also analyzed this gas in 1865, and found a trace (0·2 per cent.) of marsh gas.

Concerning his own published work the professor said the sample of gas from the Bath Spring was treated exactly in the same way as the hydrogen mixtures. During liquefaction there was a marked difference in the appearance of the liquefied gases, for while the hydrogen and air gave a clear, transparent liquid, the product from the Bath gas was turbid, and a precipitate gradually formed which by transmitted light looked yellowish-brown. This experiment was repeated. The yellowish-brown precipitate is a solid body, probably of the petroleum series of compounds, and having a marked aromatic smell. It was probably this gas which Prof. Williamson gave as marsh gas in his analysis. Further research will be made on this substance; indeed, a large quantity of gas has recently been collected for the purpose. Another peculiarity of the liquid nitrogen obtained from Bath gas is that, on examining it with a spectroscope, even through a thickness of two inches of liquid, no trace of the characteristic oxygen absorption spectrum could be obtained. In all other attempts to liquefy nitrogen on the large scale, oxygen can readily be detected in the liquid, by means of its absorption spectrum. Another phenomenon was also well shown. The gas from the King's Well could not be entirely condensed by refrigeration with liquid air boiling in vacuo. After the cooling had continued for some time, the gas ceased to flow into the condensing vessel, and the upper part of the vessel was occupied by a gas that would not undergo liquefaction or solution. The bulk of this gas was helium, an element long known to exist in the sun, but only recently discovered by Prof. Ramsay in anything terrestrial. It is, therefore, possible to separate helium from other gases by liquefaction when it is only present to the extent of one part in one thousand. From this it would appear that helium is less soluble in liquid nitrogen than hydrogen in liquid air, and is of greater volatility than the constituents of the other gases which were condensed. If the sample of the uncondensed gas from the first liquefaction of the Bath gas were again treated in the same way, a much more concentrated specimen of helium could be obtained. Provided helium were wanted on a large scale, then a liquid air apparatus similar to that in use at the Royal Institution, transported to Bath and worked with the gas from the King's Well, could be made to yield a good supply, as the gas contains 12 parts in 10,000.

Argon, which is present in the proportion of 140 parts per 10,000, condenses with the nitrogen; but if the liquid be allowed to slowly boil away, a residuum may be obtained containing about 7 per cent. of argon. An interesting experiment was performed, showing that argon, when frozen, solidifies to a perfectly clear gas, and is only visible when passing to or from the gaseous condition. The relation of atomic weight to X rays was next discussed, shadows from various liquefied gases being thrown on the screen. The influence of various bodies in assisting high vacuum as a non-conducting jacket to vessels used in experimenting at low temperatures was next demonstrated. Prof. Dewar has shown that a good exhaustion reduces the influx of heat to one-fifth of what is conveyed when the annular space of such double-walled vessels is filled with air. If the interior walls are silvered, or excess of mercury vapor is allowed to remain, the influx of heat is diminished to one-sixth of the amount entering without the metallic coating. The total effect due to the high vacuum and silvering is to reduce the ingoing heat to one-thirtieth of the original amount; i. e., roughly, to 3⅓ per cent. In the experiment performed on Friday three similar double-walled glass tubes were mounted on a common stem. Between the walls of one of the jackets was magnesia; in another finely divided carbon was used; while the third was vacuous. Since all were mounted on the same stem, all were equally vacuous. These tubes were filled to the same level with liquid air, and the rate of evaporation noted. The liquid contained in the tube isolated by high vacuum alone lost volume much more rapidly than the other tubes. Without altering any other condition, the common stem was broken, so that air was simultaneously admitted into the jackets of the

*Lecture by Prof. Dewar before the Royal Institution, April 1, 1898.

three tubes. The rate of evaporation was at once reversed, and was slowest in the tube jacketed with air alone.

HISTORY OF THE STONE ARCH.*

By Prof. MALVERD A. HOWE, Member of Engineers' Club of St. Louis.

THE "Century Dictionary" defines the word "arch," in connection with architecture, as a "structure built of separate and inelastic blocks, assembled in such a way as to retain their position when the structure is supported extraneously only at its extremities."

According to this definition, the arch must be very rare. In fact, it is doubtful whether it exists, as, up to the present day, physicists have been unable to find any inelastic substance from which to cut blocks.

Prof. Greene, in his text book entitled "Trusses and Arches," defined an arch as follows: "An arch may be considered to be any structure which, under the action of vertical forces, exerts horizontal or inclined forces against its supports or abutments."

It is to be noted that the particular form of the structure is not specified; and this is right, since, even in masonry structures where the true arch is employed, we have many different forms.

The primitive form of the arch was probably used over doorways or entrances in the form of two slabs of stone strutted against each other, as the rafters in the modern roof. The earliest example of this form, of which we have any definite information, is that over the entrance to the great pyramid of Gizeh, constructed by Khufu some time between 3124 and 4235 B. C. (A photograph indicates that this is a true arch.)

Tuckerman, in his "Short History of Architecture," states that some of the chambers in this pyramid are roofed with slabs of stones inclined like rafters. The "Encyclopedia Britannica" makes no mention of this, but states that the third pyramid contains a chamber ceiled with a pointed arch, adding that this is not a true arch, the stones being merely strutted against each other, as over the entrance to the great pyramid, and that the underside is cut to the form of a pointed arch. In a small sketch, the "Encyclopedia" gives a cross section of the vaulted chamber where the roof stones are shown extending quite a distance into the masonry back of the side walls. If such is actually the condition, the roof is not a true arch, but an arched roof.

Crude arches of brick were found in the ruins of Thebes, which were probably built as early as 2900 B. C.

Beneath the palaces of Nimrod (about 19 miles below Nineveh, on the left bank of the Tigris River), the ancient Calah, founded 1300 B. C., sewers were found covered with pointed arches of brick.

These arches, contrary to the usual form of to-day, were inclined, and could have been constructed without the use of a form for their support during construction.

The gates to an ancient city in Assyria, now represented by the ruins of Khorsabad, were arched with semicircular voussoir arches of stone, having spans of from 12 to 15 feet. These are supposed to date as early as the time of Sargon, who founded the city about 722–705 B. C.

One of the most important of the ancient structures in connection with the history of the stone arch is Campbell's tomb of Gizeh, supposed to have been built 600 B. C. "It is an open excavation, 53 feet 6 inches deep, 30 feet by 26 feet 3 inches on plan, with niches, etc., leading out of it. This excavation is supposed, from some indications left of a springing stone, to have been covered by an arch. If so, this would be the oldest known stone arch of a large size. In fact, it is difficult to imagine any other way in which this large excavation could have been covered."

But more interesting and important than this was the tomb, built of good masonry, which was found in the center of "the excavation." The roof was formed of three stones forming a true arch, over which was a perfectly formed voussoired arch of four distinct rings, the inner ring having a span of about 11 feet. These arches were nearly, if not quite, semicircular.

At about this time the Romans commenced the use of the voussoired arch, as witnessed by the outlet of the Cloaca Maxima, supposed to have been built 615 B. C. (Fig. 2). The arch consists of three concentric

FIG. 1.—VALLEY OF FLEMENGOS, FAYAL, AZORES.

FIG. 2.—CLOACA MAXIMA, ROME, ITALY.

FIG. 3.—BRIDGE OF AUGUSTUS, RIMINI, ITALY.

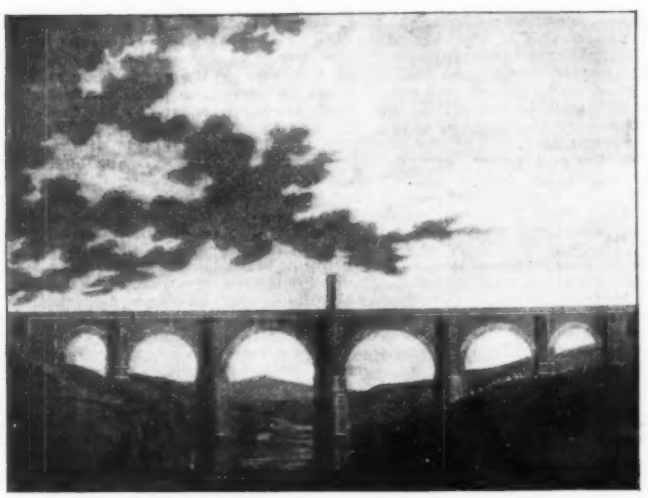


FIG. 4.—OLD STONE BRIDGE AT ALCANTARA, SPAIN (105 A. D.)

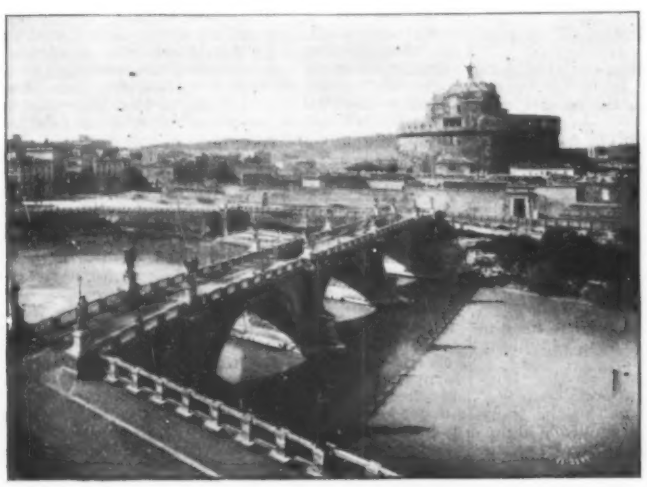


FIG. 5.—ST. ANGELO, ROME, ITALY.

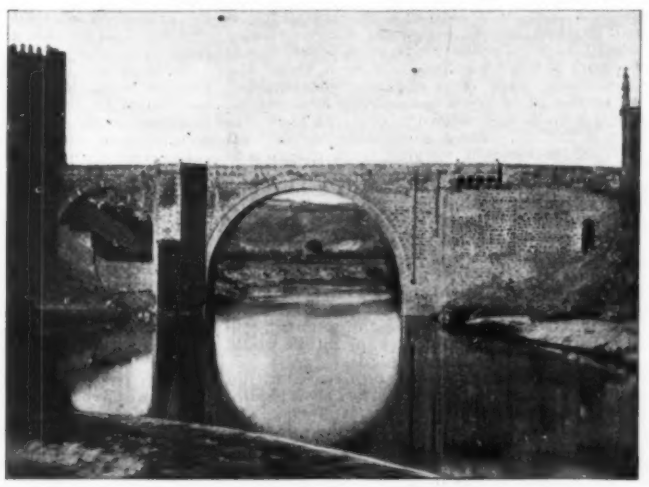


FIG. 6.—BRIDGE ALCANTARA, TOLEDO, SPAIN.

* Read before the club, December 1, 1897, and published in the Journal of the Association of Engineering Societies, to which we are indebted for the engravings and article.

rings of voussoirs, the inner ring having a span of about 14 feet.

All records in the form of ruins, tablets, etc., fail to indicate that the true arch was employed in structures to any great extent prior to the sixth century B. C. The arched form, however, was quite common from earliest times, and ruins have been found in all portions of the world.*

One of the best examples of the false arch exists in Greece. It was built probably as early as 1000 B. C. This is the Treasury of Atreus, at Mycenæ, which consists of two underground chambers, one much larger than the other. The larger chamber is circular, and is entered by a huge doorway at the end of a long avenue.

The internal form is that of an immense lime kiln. The masonry consists of horizontal projecting courses of stone, the inner projecting corners being cut off.

The arched form does not prove that the builder was familiar with the true arch, but the manner in which the horizontal courses are constructed clearly indicates that he had some idea of the true arch, as either each stone is cut wedge shape, like voussoirs in a vertical arch, or the joints are tightly wedged with small stones. The internal diameter of the chamber at the base is 48 feet 6 inches and the clear height 45 feet.

In Asia Minor tombs were found having arched roofs made by corbeling out horizontal courses of stone until they met at the top, and then cutting off the projecting edges underneath. Lübke, in his "History of Architecture," states that these were probably constructed as early as 700 B. C.

The arch was first used by the Romans for the construction of stone bridges in the second century B. C., though stone was probably employed for this purpose much earlier. The early stone bridges were constructed by building piers in the stream so close together that the opening could be spanned by stone beams. (Fig. 1 shows this style of construction.)

The bridge over the Euphrates River at Babylon was probably built in this manner.

There are a large number of examples of the true arch in bridge construction in China, as well as the primitive form of stone bridges without arches. The date at which these bridges were constructed is unknown, but many believe that the Chinese built the true arch long before it was known to the western world.

There is an account of a bridge over a river named Laffranyi, China, connecting two mountains. The bridge is said to be of one arch of stone, having a span of 600 feet and a height of 750 feet ("Edinburgh Encyclopedia"). The authority for this account is not authentic, and, although a stone bridge of such mag-

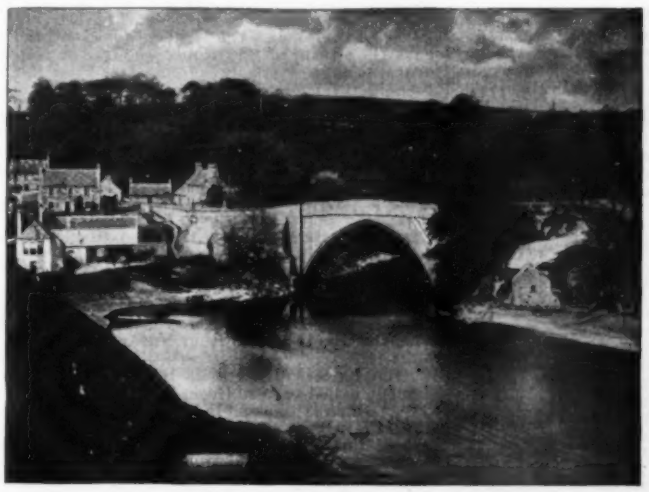


FIG. 7.—BRIG O'BALGOWNIE, ABERDEEN, SCOTLAND.

FIG. 8.—KARLSBRUCKE OVER MOLDAU, PRAGUE, AUSTRIA.

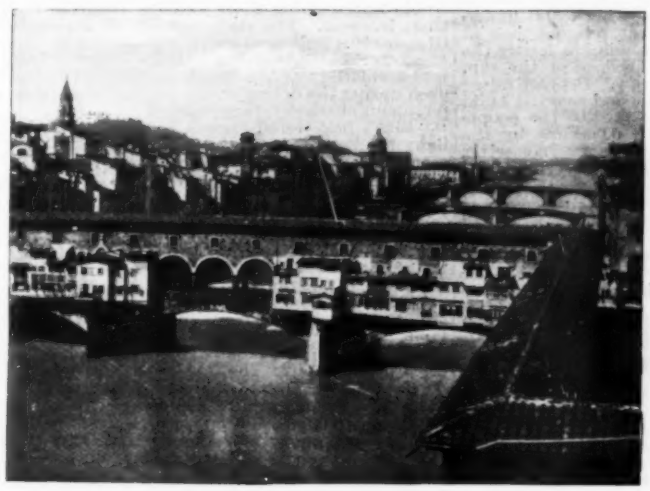


FIG. 9.—VECCHIO BRIDGE, FLORENCE, ITALY.

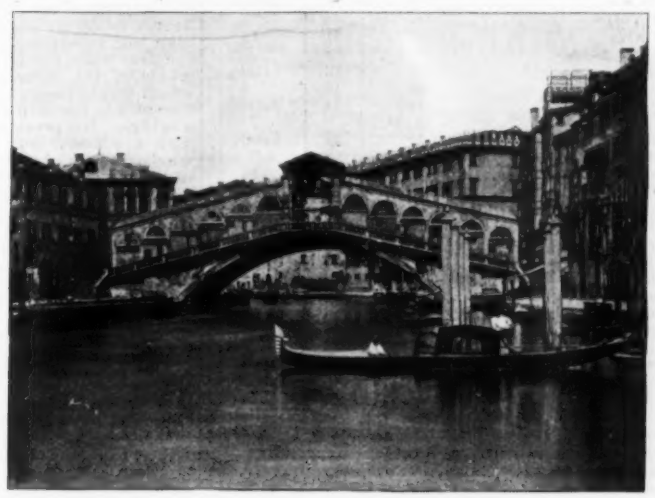


FIG. 10.—RIALTO, VENICE, ITALY.

FIG. 11.—FLEISCH-BRUCKE, NUREMBERG.

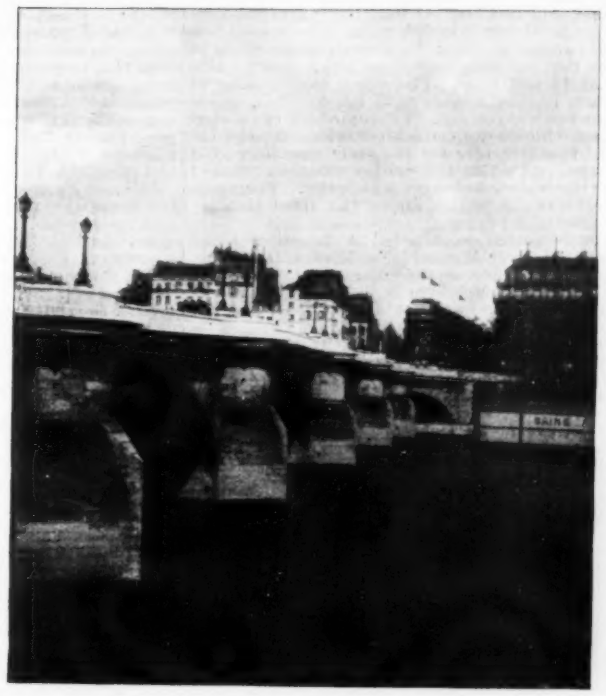


FIG. 12.—PONT NEUF, PARIS, FRANCE.

*Quite recently a voussoired arch of mud brick was discovered at Nippur (Fig. 26). The date of its construction is placed at about 4000 B. C.

nitude is not impossible from the engineer's point of view, it is yet improbable.

The old voussoired arch bridges of the Chinese are interesting from a peculiarity of the arch ring. "Each stone from 5 to 10 feet in length is cut so as to form the segment of the arch, and in such cases there is no key-stone; ribs of wood fitted to the convexity of the arch are bolted through the stones by iron bars fixed into the solid part of the bridge; sometimes they are without wood and the curved stones are mortised into long transverse blocks of stone."

The details of the more modern Chinese arches do not differ essentially from those employed in other countries.

To the Romans we are indebted for the almost universal use of the voussoired semicircular arch in bridge construction. From the second century B. C. until the fourth century A. D. the Romans built many magnificent stone arch bridges for roads and aqueducts, the magnitude of which has not since been equaled. It would take too much time to enumerate the many bridges in Rome and in the conquered provinces which were constructed by the Romans, and of which we have either authentic details or the structure itself; so we will mention only a few of the most important structures.

In the city of Rome and in the immediate vicinity were constructed aqueduct bridges containing immense amounts of masonry, and throughout these the voussoir arch was employed. The following table gives, in the chronological order of their construction, the number of miles of arches used in supporting aqueducts. (Mr. F. W. Blackford, in Journal of the Association of Engineering Societies, December, 1896.)

Name.	Date.	Total Length in Miles	Length of Arches in Miles.
	B. C.		
Appia	312	11	Little.
Anio Vetus	272–264	43	"
Marcia	145	61	12
Hercules bridge		3	
Tepula	126	13	Little.
Julia	34	15	6
Virgo	21	14	Little.
	A. D.		
Alsientina	10	22	Little.
Augusta	10	6	"
Claudia	50	46	10
Anio Novus	52	58	9
Neronian bridge	97	2	2
Triana	109	42	Little.
Hadriana	117	15	7
Sabina Augusta	130	15	Little.
Aurelia	162	16	*7
Severiana	200	10	Unknown.
Antoniana bridge	215	3	3
Alexandrina	226	15	†7
Totals		410	63

Remarks: * Restored 1585–1590. † On arches of Hadrian.

From this it is seen that between 312 B. C. and 226 A. D. sixty-three miles of arch bridges were built.

Pont du Gard, near Nimes, France, was built by the Romans during the reign of Augustus (27 B.C.–14 A.D.) under the direction of Agrippa. This is an aqueduct bridge composed of three tiers of arches. The lower tier contains six arches. The maximum span is 80 feet 5 inches. Each arch is made up of four separate rings, side by side, and not bonded together. The platform of this tier is 20 feet 9 inches wide. The second tier contains 12 arches of about the same span as those in the lower tier, but has only three rings side by side and is but 15 feet wide. The upper tier contains 36 arches, each having a span of 15 feet 9 inches, and is 11 feet 9 inches wide on top. The aqueduct channel is about 4 feet 9 inches deep and 4 feet wide. At the beginning of the fifth century the ends were destroyed by barbarians. In 1743 the bridge was repaired and the lower tier widened to carry a highway. The maximum height of the bridge above the river Gardon, which it crosses, is 160 feet.

Emperor Augustus constructed a beautiful stone bridge over the river Marecchia, at Rimini, Italy (Fig. 3). It consists of five semicircular arches having a span of 23 feet. This bridge is in use at the present day, and from all appearances has required but few repairs.

The most magnificent bridge built by the Romans was constructed in the reign of Augustus, near Narni, Italy. It consisted of four arches having spans of 75, 135, 114 and 142 feet respectively.

About 104 A. D., during the reign of Trajan, the aqueduct bridge at Segovia, Spain, was built. The bridge contains 109 arches in two tiers. Thirty of the arches are modern, but similar to the old ones. The length of the bridge is over 2,500 feet. The three center arches are 102 feet high. The entire structure is built of squared granite blocks, without mortar. During this same period, Trajan constructed a fine stone bridge over the Tagus River, at Alcantara, Spain (Fig. 4). There were six semicircular arches of various spans, the maximum being about 100 feet. The total length of the bridge was 670 feet and the maximum height above the river was 210 feet. The material was granite, laid without mortar. The bridge was in use until 1809, when the English destroyed the second arch on the right bank of the river. This was temporarily repaired, but again destroyed in 1836, since when no repairs have been made, the natives using a ferryboat to cross the stream.

In 135 A. D., during the reign of Hadrian, the bridge now called St. Angelo was built at Rome (Fig. 5). It consists of four circular arches, the span of the largest being 62 feet 4 inches. This structure is supposed to have been covered with a roof of bronze, supported by forty-two columns. It was repaired by Popes Nicholas III. and Clement IX.

The present balustrade, statues, etc., are, of course, recent, but the arches are old. In nearly all of the Roman bridges the arch was semicircular in form, and although the segmental and pointed forms may have been known, they were never employed in the construction of bridges. The spans of the arches were usually small in comparison with a few of our modern structures, yet they successfully built bridges with spans of 142 feet, which is exceeded by but a small percentage of the structures built since the seventeenth century.

Another interesting fact in connection with the Roman bridges is that the centering was almost always supported upon large stones projecting from the piers below the springing line. These are clearly shown in photographs of the Pont du Gard and the aqueduct bridge near Segovia.

We come now to a period of several centuries in which little was done in bridge building or in keeping in repair the bridges already erected, though we may mention two bridges constructed by the Moors in Spain. At Cordova, about 912–916 (?), was built a bridge of sixteen arches over the Guadalquiver. The style is a combination of the Roman and Moorish types.

In 997, at Toledo, Spain, the bridge Alcantara was built over the Tagus River (Fig. 6). It consists of practically two spans, the larger being 93 feet. The style of the structure is Roman and Moorish; the arches are semicircular, while the tower has the stamp of Moorish origin.

In the twelfth century the art of bridge building revived.

Owing to the destruction of many of the old Roman bridges and the unsettled condition of many districts, there was little "security for travelers, particularly in passing rivers, where violent exactions were made by banditti." "To put a stop to these disorders, sundry persons formed themselves into fraternities, which became a religious order, under the title of 'Brothers of the Bridge.' The object of this institution was to build bridges, ferry boats and receive travelers in the hospitals on the shores of rivers."

The first established was upon the Durance, at a dangerous place named Maupas; but in consequence of the accommodations arising from the establishment, the same place acquired the name of Bonpas. St. Benezet, who proposed and directed the building of the bridge of Avignon, was a shepherd, and was not twelve years of age when he received revelations from heaven commanding him to quit his flock and undertake this enterprise. He arrived at Avignon just at the time when the bishop was preaching to fortify the minds of the people against an eclipse of the sun, which was to happen upon that day. Benezet raised his voice in the church and said he had come to build a bridge. His proposition was accepted by the people with applause, but rejected with contempt by the magistrates and by those who thought themselves wisest. As it was at this time an act of piety to build bridges, and Avignon being then a popular republic, the people prevailed, and every one contributed to the good work; some by money and some by labor, all under the direction of Benezet, aided by the Brothers. St. Benezet, by performing a great number of miracles, animated the zeal of everybody. Upon the third pier was erected a chapel to St. Nicholas, protector of those who navigate rivers. This was done, however, after the death of St. Benezet, which happened in 1184 ("Edinburgh Encylopedia").

This bridge, which was composed of eighteen or twenty-one arches, was begun in 1176 and completed in 1188. In 1385 Pope Boniface IX. destroyed some of the arches. In 1410 the inhabitants blew up a tower, causing the fall of three spans. In 1670 the cold was so severe that the Rhone for several weeks bore the heaviest carriages; when the thaw followed, the ice destroyed the piers; but the third pier, with the chapel of St. Nicholas, has remained, notwithstanding these many accidents. The span of the largest arch was about 102·9 feet, and was semicircular. (Authorities differ here, some claiming that the arch had a span of 110 feet and was segmental. The "Encyclopedia Britannica" states that the arches were elliptical, the minimum radius of curvature being at the crown.)

In 1176, or practically at the time when the bridge at Avignon was commenced, Peter of Colchester, a priest, began the erection of the old London bridge across the Thames, but the structure was not completed until 1209. The bridge originally contained nineteen pointed arches having spans from 9 to 20 feet and piers 25 to 34 feet thick.

For many years there were houses along each side, but these were removed in 1758, and the middle pier and two arches replaced by a single arch of 72 feet span. In 1824–31 the new London bridge replaced this structure.

In 1203 the bridge St. Martin was built over the Tagus River at Toledo, Spain. It consists of five arches, the center arch being the largest, with a span of 132 feet. This arch is very slightly pointed.

In 1281 the Brig O'Balgownie was built over the river Don on the road leading from the old to the new town of Aberdeen, Scotland (Fig. 7). This bridge contains but one arch, which is pointed, and has a span of 66 feet.

These bridges with pointed arches, constructed in different countries, place the introduction of such arches in bridge building at about the thirteenth century.

The old Charles bridge over the Moldau, Prague, Austria, was built between 1357 and 1507 (Fig. 8). It consisted of sixteen spans, the largest being 69·5 feet. In a photograph the arches appear to be semicircular. The structure was ornamented with thirty statues and groups of saints, one of which is a bronze statue of St. John Nepomuc, patron saint of Bohemia (in whose memory the bridge is visited yearly by thousands of pilgrims). The saint is said to have been flung from the bridge in 1383 by order of the Emperor for refusing to betray the confessions of the Empress. The body is said to have floated for some time with five brilliant stars hovering over the head. The bridge was partially destroyed by a flood in 1890.

In 1380 a very large arch was built over the Adda River near Trezzo, Italy, by order of Visconti, but was destroyed by Carmagnola in 1416. From the ruins which remained in 1888 (about 20 feet at each abutment) the span has been determined to have been about 251 feet and the rise about 88 feet. The arch ring was remarkable as being in two concentric rings with a total thickness of but 4 feet.

The Vecchio bridge at Florence, Italy (Fig. 9), over the Arno River, was first built in 1177, but was rebuilt in 1345. It consists of three arches of 96 feet span and 19·2 feet rise, the curves being segments of a circle and in appearance quite flat. The width of the structure is 105 feet, and along the sides are built stores, etc.

Adjacent to the Vecchio bridge, the Trinity bridge was erected in 1566. It consists of three elliptical arches, the largest having a span of 95·8 feet and a rise of 16 feet.

The Rialto, at Venice, Italy, built of marble in 1588–91, has but one span of 98·5 feet, with a rise of 23 feet (Fig. 10).

Apparently in imitation of the Rialto, the Fleischbrücke in Nuremberg was constructed in 1599, with a span of 97 feet and a rise of 13 feet (Fig. 11).

These examples of the segmental or elliptical arch mark the advent of flat arches, though, of course, the form was not universally employed, as Pont Neuf, over the Seine River, Paris, France (Fig. 12), built between 1578 and 1604, consists of a large number of nearly semicircular arches with a maximum span of 51·1 feet and a rise of 21·9 feet.

(To be continued.)

CHEMISTRY OF PLANT COLORS.

THE delicate and fleeting tints of the flowers, when looked at purely from a chemical point of view, are due to dyes—definite chemical compounds contained in the petals. Many of these have been isolated and analyzed. A few of the most common are described in The Naturalist, by Dr. P. Q. Keegan, an abstract of whose article we quote below from Natural Science, as follows:

"The buttercup owes its brilliant golden hue to a pigment called carotin (from its presence in the carrot root), 'which is amassed in discoidal bodies that nearly fill up the cells of the epidermis, especially toward the base of the petal; in other parts, especially when the flower is fully expanded, it seems diffused in oily droplets or amorphous granules.' In either case the starch grains in the subjacent tissue act as a reflector, and contribute greatly to enhance the effect. The flower heads contain a considerable amount of sugar, starch, calcium oxalate and soluble phosphates, in these respects approaching more to the character of leaves than is usual. The stem and root of this buttercup (Ranunculus bulbosus) are remarkable for the presence of an acrid camphoraceous body easily decomposed into a volatile bitter principle (anemonin) and an acid, even during the drying of the plant, so that its original poisonous character disappears.

"Bird's foot trefoil (Lotus corniculatus), with brilliant orange and crimson tints of its little papilionaceous flowers, is known to every one. To produce this vividness and luster the epidermal cells are swollen into papillæ, and contain no less than three distinct pigments. There are the solid carotin corpuscles and also two coloring matters in solution in the cell sap. One is a clear yellow juice, the other is identical with the anthocyan of the rose. Where the latter predominates we get the deep red color.

"The tiny flowers of the cheerful little yellow bedstraw (Galium verum) contain carotin, much yellow resinous matter, and 'a curious purplish substance (possibly purpurin) insoluble in cold alcohol or benzine after purification.' The flowers also contain a species of ferment which, like rennet, has the power of coagulating boiling milk. A substance known as rubichloric acid is present, not only in the flowers, but in the stem and root. It forms a colorless solution in water, but when boiled with a few drops of hydrochloric acid suddenly produces a deep blue, then a green color, and deposits a dense, dark green precipitate soluble in ammonia. The disk florets of the daisy are tinged with carotin granules; the crimson of the ray florets is due to a soluble pigment described as a tannin anhydrid. The blue of the harebell and chicory is again a tannin derivative.

"Two coloring matters are engaged in the decoration of the primrose. At the base of the petal limbs, where the tint is more deeply orange, carotin granules are present; the rest of the corolla contains a pale-yellow, soluble pigment. Although the tints are comparatively feeble, chemical analysis shows that the plant is capable of 'an infinitely richer wealth of coloration' than it shows in our climate, since 'it seems almost impossible to exhaust the flower heads of substances which yield vivid and powerful orange and yellow dyes.'"

NAVY FULL DIET TABLE.

AFTER much study the medical officers of the navy have adopted a new full diet table in which every care has been taken to provide for a proper quantity of proximate principles in a variety of food suitable for a liberal diet, says The Army and Navy Journal. For each meal in the table running through a week, the precise amounts of albuminoids, carbohydrates and fats were arranged, bearing well in mind the preferences developed by a seaman's life. The bills of fare represent not only the ideal poor man's food, but food that cannot be surpassed for royalty as well. It is found in practice, from the returns of all hospitals, that these meals cost an average of 30 cents per day per person, or about 10 cents per meal. The tables are thought to constitute the best possible fare, and represent a most excellent foundation for carrying other gastronomic luxuries. The naval full diet table is as follows for one day in the week, the number after each article relating to ounces: Breakfast—Coffee, 1; bread, 4; butter, 1; milk, 6; sugar, 1; oatmeal, 1; beefsteak, 6. Dinner—Rice soup, 8; bread, 4; roast beef or roast or boiled fowl, 8; potatoes, 8; other vegetables, 6; pickles, 1; bread pudding, with sauce, 6, or custard, frozen, 8; fresh fruit, 6. Supper—Tea, $\frac{1}{4}$; bread, 6; butter, 1; milk, 2; sugar, 1; cold roast mutton or cold roast beef, 4; stewed dried fruit or baked fresh fruit or apple sauce, 4. The staples—coffee, bread, butter, milk, sugar and fresh and dried fruit—are the same for each meal, but there is a daily variety in meats and other articles for breakfast, dinner and supper. The proportions are about the same, however, especially in the matter of meats, as in the specimen diet table given above. In addition to its use for convalescents, the table is now observed for all naval hospital employes, and is gradually becoming the standard aboard ship and in the marine corps. Its adoption was the result of most patient and thorough investigation conducted by Surgeon J. D. Gatewood, who consulted all the leading authorities on the subject.

ENGINEERING NOTES.

The war department is working on a new method of protecting gun emplacements as a substitute for masonry and concrete. An experimental emplacement is being erected at Fort Washington with a protective shield of worn-out railroad rails. This work is within range of some of the 10-inch guns which constitute a part of the Potomac River defenses at this point. A test will soon be made on the efficiency of this type of protection against heavy projectiles.

A method of centrifugal casting has been recently introduced and described by P. Huth in Stahl und Eisen by which castings similar to the ordinary chilled castings can be produced in the following way: The mould is made to rotate, when a hard steel is poured in, which flies to the sides; soft steel is then poured into the hollow center, with the result that the casting produced has a soft core and a hard face. The author suggests many applications, among which are wagon wheels with hard rims, projectiles with hard points, gear wheels with hard teeth, jaws for ore crushers, stamp dies with hard faces, plow points, and hard surface rolls of all kinds. Although both metals are intimately combined, yet the limits between them are said to be readily recognizable.

The committee of the American Society of Civil Engineers on the proper manipulation of tests of cement (of which committee Prof. George F. Swain, of the Massachusetts Institute of Technology, is chairman), has issued to members and others a circular containing a very exhaustive list of questions upon the subject named. The questions cover the matters of chemical analysis, microscopical tests, fineness, apparent and true density, tensile and compressive strength, preparation for tests, etc. The circular bears evidence of the most careful preparation, and the importance of the subject is great. The committee desires a wide circulation of the questions and suggestions or information upon any branch of the subject. It is suggested that those who have an interest in the matter will find it of advantage to communicate with Prof. Swain, at Boston, Mass.

According to Engineering News, rammed soil is being used as foundations at the site of the Paris Exposition of 1900, by M. Dulac, one of the contractors. In cases of made ground, or when the soil is loose, he uses a steam pile driver and a conical ram, with which he rapidly makes deep holes about 3 feet apart. These holes are filled with some hard material after each blow, and this material is forced sideways as well as down. The process has been patented by M. Dulac, and he claims that by thus using a suitable quantity of hard material he can make a good foundation for his superstructure, and save 30 to 40 per cent. in cost, as compared with the usual excavation, and do it in one-third the time. In very soft or water-soaked soil he proposes to use ashes mixed with a quick-setting cement; this lines the inside of the hole and produces a species of pipe for the passage of the ram. No material has to be excavated or carted away, and no bracing is needed. But he does not say whether he finally makes a continuous trench or simply a succession of holes filled with hard material, as in the case of the old, so-called, "sand piles."

The Manchester ship canal report for the half year ending December 31, 1897, is not pleasant reading for the stockholders, says Engineering News. The revenue from the Bridgewater canal alone enables the company to pay its fixed charges; and the profits from this source are greater in proportion than those from the ship canal, as the following figures show:

Ship canal receipts	$536,665
" " expenditures	441,630
" " credit	95,035
Bridgewater canal receipts	110,260

These figures can be better understood when it is realized that the books place the capital expended on the Bridgewater system at $8,921,755 and that on the ship canal at $66,889,255. The comparative interest is 1·25 per cent. on the Bridgewater canal and 0·14 per cent. on the ship canal; or, the former earns nine times as much on its capital as the latter. The traffic on the ship canal has grown, however, though less in proportion in 1897 than in preceding years. It is as follows for four years:

	1894.	1895.	1896.	1897.
Seagoing craft, tons	686,158	1,087,443	1,509,658	1,701,047
In barges, "	220,501	271,432	316,579	365,396

In a recent issue of Stahl und Eisen some interesting details are given as to the preparation of carbide of iron. It would seem that pure iron (Swedish or electrolytic) which is melted in the electric furnace in contact with pure carbon unites with it in increasing quantities as the temperature rises, and becomes more and more pasty, so that at the melting point of titanium it can no longer be poured. If the temperature is lowered, the metal again becomes liquid, and by letting it cool slowly and solidify, a gray button, full of graphite and with but little combined carbon, is obtained. By pouring into a chill while at about 2450° Fahr., white iron is obtained. If the material, while at 5400° Fahr., is suddenly chilled by throwing upon it some cold water, a product is obtained containing 5·25 per cent. of combined carbon, most of which is a carbide of iron, Fe_3C, which also exists in some quantity in steel. To get it in a pure form complete saturation of the melt and care to prevent the formation of graphite are essential. This can be well done, according to Moissan, by taking about a pound of Swedish iron, heating it in a graphite crucible for three minutes in an electric furnace with a current of 900 amperes and 600 volts, taking out the crucible and dipping it into cold water, which, by the way, can be done without danger. The hard crystalline mass is freed from surplus iron by remaining for twenty-four hours as an anode in a 7 per cent. hydrochloric acid solution, having a carbon plate for the cathode. The remaining carbide still contains some free carbon and carbohydrates, which are removed by letting it remain for some time in fuming nitric acid as free as possible from water, and to which a little potassium chlorate has been added toward the latter part of the process. The crucible is then washed in water, alcohol and ether. Under these circumstances, white crystals of Fe_3C, with a specific gravity of 7·07, are obtained.

ELECTRICAL NOTES.

It is stated by The Canadian Electrical News that the telegraph line which is to be built by the Canadian Pacific Railway, between Montreal and Vancouver, will cost $250,000. The wire to be used will be of copper, 300 pounds to the mile, and will weigh about 450 tons. It is being manufactured by the Dominion Wire Manufacturing Company, of Lachine, Que., and will be tested at McGill University under the direction of the officers of the company. The short pieces of wire which will be used to tie the telegraph wires to the insulators will have a total weight of 6½ tons.

Experiments have recently been carried out by Prof. Trowbridge, of Harvard University, by which he finds that the length of electrical discharges between widely separated points varies directly with the E. M. F. Discharges 4 ft. long were produced by means of an E. M. F. of 1,200,000 volts, and the professor made the calculation that for the discharge of a flash of lightning one mile long, at least 1,000,000,000 volts would be required. The apparatus with which the experiments were made consists of 10,000 Planté storage cells and a glass plate condenser of sixty leaves.

Experiments are about to begin at Tonawanda, on the Erie Canal, with a view to testing Prof. Short's plan of electric towage. The scheme is to haul a tow of boats by means of a locomotive on a track along and parallel to the canal banks. The mining type of locomotive is to be used, and it will be powerful enough to haul a tow of five boats, each of 50 tons burden, at a speed not exceeding six or eight miles an hour. The overhead trolley system is to be used in the experiments, and in its main features it is practically a street railway system, the locomotive, or motor car, hauling the boats behind it.

That well known electric railway, the little line which runs from Brighton to Rottingdean, England—some four miles in all—has proved so useful since it has been in work again, after the havoc wrought by the storm of December 4, 1896, was repaired, that a demand arose for an intermediate station to serve the village of Ovingdean, a retired place in a hollow of the chalky down half way between Brighton and Rottingdean. A station has been for some time under construction to meet this need, and has now been opened. It is built out at the foot of the chalk cliffs, on the seaward end of a jetty, to which access is gained by staircases cut in the chalk.

The Chemical Society of the Massachusetts Institute of Technology, composed mostly of instructors in the chemical department, have described recently a new process of preserving meats, says the English Electrical Engineer. The process proposed is simply to sterilize the meats by placing them for a certain number of hours close to an electric light. The actinic rays of light, not only from an electric light, but from almost any kind of light, are fatal in time to all kinds of germs, even in the bacteria of anthrax. While the meats are exposed to the light, a stream of hot air at temperatures ranging from 115° F. to 150° F. is sent up through the box in which the meats are placed to dry them. Then the thoroughly dried meats are powdered, and are thus ready for Klondike expeditions and for army and navy use.

In an article in a recent issue of The American Electrician Mr. H. S. Hering states that, as the result of tests, he finds the difference between making a stop and a start at a station and running past it varies from 75 to 100 watt hours, depending upon the gradient and load. The average value under ordinary conditions for a partially loaded 7½ ton car is 85 watt hours. Assuming the cost of electrical energy to be 1 cent per kilowatt hour, one stop would cost 0·085 cent, and the cost of making one unnecessary stop on each trip for fifteen trips daily would amount to $4.67 per car per year, and for 100 cars $467 per year for the one extra stop per trip. About 74 per cent. of the total energy required for propulsion is expended in accelerating and lifting a car, showing that if only one-half of the energy stored in a moving car could be saved, the saving would be very large. By careful driving a saving of from 10 to 20 per cent. might be effected.

According to L'Industrie Electrique, it is proposed to build an electric tramway between Rome and Genzano with a branch in the direction of Rocca di Papa. The line will be of normal gage, and the rails will be laid on oak sleepers placed at distances of about 3 feet apart. The steepest gradient will not exceed 9 per cent. and the sharpest curve 92 feet radius. The length of the line will be about 26 miles, divided into three nearly equal sections forming a Y. The generating station is to be at Capanne di Marino at the center of the Y, and will comprise five Dowson gas engines, each of 120 horse power, driving continuous current dynamos. One of these three sets constitutes a reserve. The station will also supply light to the streets and villas of Castelli Romani. The adoption of gas engines is primarily due to the lack of water. Overhead distribution at 1,200 volts is used with the rails as return. Motor cars are to be used with one or two trailers as required. The speed will vary from 9½ to 18½ miles an hour, and each motor car will carry two 35 horse power motors.

There are a few women in this country who have received a technical education in electricity, and one that we can call to mind at the present time is practicing the profession at Pittsburg, holding a position of some responsibility with the Westinghouse Electrical Manufacturing Company, says the New York correspondent of The Electrician. Another instance of the business capacity of women in this direction is that of a Southern lady, who is an electrical engineer and contractor, and seems to be equal to the average engineer of the male persuasion. Another woman, this time in Ohio, has acquired some prominence as a superintendent of a prosperous electric railway. She is only twenty years of age, and from all accounts is not behind her male competitors in operating the line. In New York State there is a woman wire contractor, and she does considerable business in this line, in her section of the State. New Jersey also enjoys the distinction of having an eccentric person, who runs an electric car on one of the Jersey roads. She seems to be fascinated with the work; but it is stated she has recently been persuaded to give it up, chiefly on account of the objections on the part of her men companions on the road and of her husband.

SELECTED FORMULÆ.

Reducers.—The best of these is undoubtedly Belitzski's; it keeps well in the dark and may be used over and over again till the solution turns yellow, and does not require the negative to be freed from hypo:

Potassium ferric oxalate	20 g.
Sodium sulphite	20 "
Distilled water	250 c. c.

Dissolve and add

Oxalic acid (crystal)	7·5 g.

and shake till the blood red solution turns green, decant from any undissolved acid and filter and add

Hypo	125 g.
Distilled water to make	1,000 c. c.

This is applicable to negatives, transparencies and bromide papers.

Varnishes.—Amateurs are not fond of varnishing, but the advantages are decidedly great as regards the permanency of the negatives. One of the greatest objections to the use of varnish is the necessity of heating the negative. Therefore, a cold varnish is preferable.

GOLD SIZE VARNISH.

Japanners' gold size (best)	Equal parts.
Benzole	

This is to be applied cold, and sets in half an hour to a very hard resistant film.

ZAPON VARNISH.

Thin transparent celluloid	20 g.
Acetone	300 c. c.
Amyl acetate	200 "

The objection to this is the unpleasant smell and the time the varnish takes to thoroughly harden.

Film Varnish.—As the basis of all films is celluloid, it is obvious that some varnish without a celluloid solvent as the vehicle must be used.

Bleached or pale shellac (powdered)	125 g.
Liq. ammonia fort	250 c. c.
Absolute alcohol	250 "

Macerate for 48 hours and then digest in a water bath till the shellac has dissolved and add

Distilled water to	1,000 c. c.

Filter.

This may be applied to the wet or dry films, and the best way is to put sufficient varnish in a dish and bodily immerse the films and then hang up to dry.

ORDINARY NEGATIVE VARNISH.

Pale yellow shellac	150 g.
Sandarac	18 "
Castor oil	1 c. c.
Absolute alcohol (or old methylated)	1,000 "

The negative must be heated before this is applied.

CRYSTAL VARNISH (FOR TRANSPARENCIES).

Gum dammar	50 g.
Benzole	1,000 c. c.

This can be used cold. It is not so resistant as those given above.

Toning Baths.—For the old albumenized paper it is usual to employ neutral or alkaline baths, and acetate, phosphate, tungstate or borate of soda are generally used. A typical formula is:

Gold chloride	0·4 g.
Sodium acetate	16 "
Distilled water to	1,000 c. c.

Gelatino-Chloride Toning Baths.—The best formula is the following; it is suitable for all kinds of papers, though with some it yields finer tones than others:

Gold chloride	1 g.
Potassium sulphocyanide	2 "
Distilled water	180 c. c.

Dissolve and heat to the boiling point for five minutes and add distilled water to make 200 c. c.. For use mix 1 part of this with 15 parts of water.

Combined Toning and Fixing Baths.—Amateurs will have these, but their use should be discouraged as much as possible, but the following is a simple formula:

No. 1.

Lead nitrate	10 g.
Hypo	200 "
Distilled water	1,000 c. c.

No. 2.

Chloride of gold	10 g.
Distilled water to	100 c. c.

This solution must be absolutely free from acid. Just before use mix 5 parts of No. 2 with 1,000 parts of No. 1. The prints must be bathed in a 1 per cent. solution of bicarbonate of soda, well washed, and then immersed in the toning bath.

A Combined Toning Bath Without Lead.—

Hypo	240 g.
Ammonium sulphocyanide	24 "
Sodium acetate (fused)	48 "
Distilled water to	1,000 c. c.

To this, just before use, add 1 gramme of neutral chloride of gold.

Developer for Gelatino or Chloride.—It is not generally known that gelatino or collodio chloride paper can be developed, and in the winter time or in summer, when a large number of prints have to be obtained, this is a great advantage. The paper should only be faintly printed, just sufficient to show all the details, and then developed with the following:

No. 1.

Hydroquinone	10 g.
Alcohol	100 "

No. 2.

Sodium sulphite	100 g.
Citric acid	5 "
Distilled water to	500 c. c.

For use mix 50 parts of No. 1, 50 parts of No. 2 and 1,000 parts of water. Development will be complete in from 10 to 15 minutes, and the prints should be transferred to a 5 per cent. solution of salt, well washed and then washed in the combined toning and fixing bath.—Pharm. Jour.

nitude is not impossible from the engineer's point of view, it is yet improbable.

The old voussoired arch bridges of the Chinese are interesting from a peculiarity of the arch ring. "Each stone from 5 to 10 feet in length is cut so as to form the segment of the arch, and in such cases there is no key-stone; ribs of wood fitted to the convexity of the arch are bolted through the stones by iron bars fixed into the solid part of the bridge; sometimes they are without wood and the curved stones are mortised into long transverse blocks of stone."

The details of the more modern Chinese arches do not differ essentially from those employed in other countries.

To the Romans we are indebted for the almost universal use of the voussoired semicircular arch in bridge construction. From the second century B. C. until the fourth century A. D. the Romans built many magnificent stone arch bridges for roads and aqueducts, the magnitude of which has not since been equaled. It would take too much time to enumerate the many bridges in Rome and in the conquered provinces which were constructed by the Romans, and of which we have either authentic details or the structure itself; so we will mention only a few of the most important structures.

In the city of Rome and in the immediate vicinity were constructed aqueduct bridges containing immense amounts of masonry, and throughout these the voussoir arch was employed. The following table gives, in the chronological order of their construction, the number of miles of arches used in supporting aqueducts. (Mr. F. W. Blackford, in Journal of the Association of Engineering Societies, December, 1896.)

Name.	Date.	Total Length in Miles	Length of Arches in Miles.
	B. C.		
Appia	312	11	Little.
Anio Vetus	272–264	43	"
Marcia	145	61	12
Hercules bridge		3	.....
Tepula	126	13	Little.
Julia	34	15	6
Virgo	21	14	Little.
	A. D.		
Alsientina	10	22	Little.
Augusta	10	6	"
Claudia	50	46	10
Anio Novus	52	58	9
Neronian bridge	97	3	2
Triana	109	42	Little.
Hadriana	117	15	7
Sabina Augusta	130	15	Little.
Aurelia	162	16	*7
Severiana	200	10	Unknown.
Antoniana bridge	215	3	3
Alexandrina	226	15	†7
Totals		410	63

Remarks: * Restored 1585–1590. † On arches of Hadrian.

From this it is seen that between 312 B. C. and 226 A. D. sixty-three miles of arch bridges were built.

Pont du Gard, near Nimes, France, was built by the Romans during the reign of Augustus (27 B.C.–14 A.D.) under the direction of Agrippa. This is an aqueduct bridge composed of three tiers of arches. The lower tier contains six arches. The maximum span is 80 feet 5 inches. Each arch is made up of four separate rings, side by side, and not bonded together. The platform of this tier is 20 feet 9 inches wide. The second tier contains 12 arches of about the same span as those in the lower tier, but has only three rings side by side and is but 15 feet wide. The upper tier contains 36 arches, each having a span of 15 feet 9 inches, and is 11 feet 9 inches wide on top. The aqueduct channel is about 4 feet 9 inches deep and 4 feet wide. At the beginning of the fifth century the ends were destroyed by barbarians. In 1743 the bridge was repaired and the lower tier widened to carry a highway. The maximum height of the bridge above the river Gardon, which it crosses, is 160 feet.

Emperor Augustus constructed a beautiful stone bridge over the river Marecchia, at Rimini, Italy (Fig. 3). It consists of five semicircular arches having a span of 23 feet. This bridge is in use at the present day, and from all appearances has required but few repairs.

The most magnificent bridge built by the Romans was constructed in the reign of Augustus, near Narni, Italy. It consisted of four arches having spans of 75, 135, 114 and 142 feet respectively.

About 104 A. D., during the reign of Trajan, the aqueduct bridge at Segovia, Spain, was built. The bridge contains 109 arches in two tiers. Thirty of the arches are modern, but similar to the old ones. The length of the bridge is over 2,500 feet. The three center arches are 102 feet high. The entire structure is built of squared granite blocks, without mortar. During this same period, Trajan constructed a fine stone bridge over the Tagus River, at Alcantara, Spain (Fig. 4). There were six semicircular arches of various spans, the maximum being about 100 feet. The total length of the bridge was 670 feet and the maximum height above the river was 210 feet. The material was granite, laid without mortar. The bridge was in use until 1809, when the English destroyed the second arch on the right bank of the river. This was temporarily repaired, but again destroyed in 1836, since when no repairs have been made, the natives using a ferryboat to cross the stream.

In 135 A. D., during the reign of Hadrian, the bridge now called St. Angelo was built at Rome (Fig. 5). It consists of four circular arches, the span of the largest being 62 feet 4 inches. This structure is supposed to have been covered with a roof of bronze, supported by forty-two columns. It was repaired by Popes Nicholas III. and Clement IX.

The present balustrade, statues, etc., are, of course, recent, but the arches are old. In nearly all of the Roman bridges the arch was semicircular in form, and although the segmental and pointed forms may have been known, they were never employed in the construction of bridges. The spans of the arches were usually small in comparison with a few of our modern structures, yet they successfully built bridges with spans of 142 feet, which is exceeded by but a small percentage of the structures built since the seventeenth century.

Another interesting fact in connection with the Roman bridges is that the centering was almost always supported upon large stones projecting from the piers below the springing line. These are clearly shown in photographs of the Pont du Gard and the aqueduct bridge near Segovia.

We come now to a period of several centuries in which little was done in bridge building or in keeping in repair the bridges already erected, though we may mention two bridges constructed by the Moors in Spain. At Cordova, about 912–916 (?), was built a bridge of sixteen arches over the Guadalquiver. The style is a combination of the Roman and Moorish types.

In 997, at Toledo, Spain, the bridge Alcantara was built over the Tagus River (Fig. 6). It consists of practically two spans, the larger being 93 feet. The style of the structure is Roman and Moorish; the arches are semicircular, while the tower has the stamp of Moorish origin.

In the twelfth century the art of bridge building revived.

Owing to the destruction of many of the old Roman bridges and the unsettled condition of many districts, there was little "security for travelers, particularly in passing rivers, where violent exactions were made by banditti." "To put a stop to these disorders, sundry persons formed themselves into fraternities, which became a religious order, under the title of 'Brothers of the Bridge.' The object of this institution was to build bridges, ferry boats and receive travelers in the hospitals on the shores of rivers."

The first established was upon the Durance, at a dangerous place named Maupas; but in consequence of the accommodations arising from the establishment, the same place acquired the name of Bonpas. St. Benezet, who proposed and directed the building of the bridge of Avignon, was a shepherd, and was not twelve years of age when he received revelations from heaven commanding him to quit his flock and undertake this enterprise. He arrived at Avignon just at the time when the bishop was preaching to fortify the minds of the people against an eclipse of the sun, which was to happen upon that day. Benezet raised his voice in the church and said he had come to build a bridge. His proposition was accepted by the people with applause, but rejected with contempt by the magistrates and by those who thought themselves wisest. As it was at this time an act of piety to build bridges, and Avignon being then a popular republic, the people prevailed, and every one contributed to the good work; some by money and some by labor, all under the direction of Benezet, aided by the Brothers. St. Benezet, by performing a great number of miracles, animated the zeal of everybody. Upon the third pier was erected a chapel to St. Nicholas, protector of those who navigate rivers. This was done, however, after the death of St. Benezet, which happened in 1184 ("Edinburgh Encylopedia").

This bridge, which was composed of eighteen or twenty-one arches, was begun in 1176 and completed in 1188. In 1385 Pope Boniface IX. destroyed some of the arches. In 1410 the inhabitants blew up a tower, causing the fall of three spans. In 1670 the cold was so severe that the Rhone for several weeks bore the heaviest carriages; when the thaw followed, the ice destroyed the piers; but the third pier, with the chapel of St. Nicholas, has remained, notwithstanding these many accidents. The span of the largest arch was about 102·9 feet, and was semicircular. (Authorities differ here, some claiming that the arch had a span of 110 feet and was segmental. The "Encyclopedia Britannica" states that the arches were elliptical, the minimum radius of curvature being at the crown.)

In 1176, or practically at the time when the bridge at Avignon was commenced, Peter of Colchester, a priest, began the erection of the old London bridge across the Thames, but the structure was not completed until 1209. The bridge originally contained nineteen pointed arches having spans from 9 to 20 feet and piers 25 to 34 feet thick.

For many years there were houses along each side, but these were removed in 1758, and the middle pier and two arches replaced by a single arch of 72 feet span. In 1824–31 the new London bridge replaced this structure.

In 1203 the bridge St. Martin was built over the Tagus River at Toledo, Spain. It consists of five arches, the center arch being the largest, with a span of 132 feet. This arch is very slightly pointed.

In 1281 the Brig O'Balgownie was built over the river Don on the road leading from the old to the new town of Aberdeen, Scotland (Fig. 7). This bridge contains but one arch, which is pointed, and has a span of 66 feet.

These bridges with pointed arches, constructed in different countries, place the introduction of such arches in bridge building at about the thirteenth century.

The old Charles bridge over the Moldau, Prague, Austria, was built between 1357 and 1507 (Fig. 8). It consisted of sixteen spans, the largest being 69·5 feet. In a photograph the arches appear to be semicircular. The structure was ornamented with thirty statues and groups of saints, one of which is a bronze statue of St. John Nepomuc, patron saint of Bohemia (in whose memory the bridge is visited yearly by thousands of pilgrims). The saint is said to have been flung from the bridge in 1383 by order of the Emperor for refusing to betray the confessions of the Empress. The body is said to have floated for some time with five brilliant stars hovering over the head. The bridge was partially destroyed by a flood in 1890.

In 1380 a very large arch was built over the Adda River near Trezzo, Italy, by order of Visconti, but was destroyed by Carmagnola in 1416. From the ruins which remained in 1838 (about 20 feet at each abutment) the span has been determined to have been about 251 feet and the rise about 88 feet. The arch ring was remarkable as being in two concentric rings with a total thickness of but 4 feet.

The Vecchio bridge at Florence, Italy (Fig. 9), over the Arno River, was first built in 1177, but was rebuilt in 1345. It consists of three arches of 96 feet span and 19·2 feet rise, the curves being segments of a circle and in appearance quite flat. The width of the structure is 105 feet, and along the sides are built stores, etc.

Adjacent to the Vecchio bridge, the Trinity bridge was erected in 1566. It consists of three elliptical arches, the largest having a span of 95·8 feet and a rise of 16 feet.

The Rialto, at Venice, Italy, built of marble in 1588–91, has but one span of 98·5 feet, with a rise of 23 feet (Fig. 10).

Apparently in imitation of the Rialto, the Fleischbrücke in Nuremberg was constructed in 1599, with a span of 97 feet and a rise of 13 feet (Fig. 11).

These examples of the segmental or elliptical arch mark the advent of flat arches, though, of course, the form was not universally employed, as Pont Neuf, over the Seine River, Paris, France (Fig. 12), built between 1578 and 1604, consists of a large number of nearly semicircular arches with a maximum span of 51·1 feet and a rise of 21·9 feet.

(To be continued.)

CHEMISTRY OF PLANT COLORS.

The delicate and fleeting tints of the flowers, when looked at purely from a chemical point of view, are due to dyes—definite chemical compounds contained in the petals. Many of these have been isolated and analyzed. A few of the most common are described in The Naturalist, by Dr. P. Q. Keegan, an abstract of whose article we quote below from Natural Science, as follows:

"The buttercup owes its brilliant golden hue to a pigment called carotin (from its presence in the carrot root), 'which is amassed in discoidal bodies that nearly fill up the cells of the epidermis, especially toward the base of the petal; in other parts, especially when the flower is fully expanded, it seems diffused in oily droplets or amorphous granules.' In either case the starch grains in the subjacent tissue act as a reflector, and contribute greatly to enhance the effect. The flower heads contain a considerable amount of sugar, starch, calcium oxalate and soluble phosphates, in these respects approaching more to the character of leaves than is usual. The stem and root of this buttercup (Ranunculus bulbosus) are remarkable for the presence of an acrid camphoraceous body easily decomposed into a volatile bitter principle (anemonin) and an acid, even during the drying of the plant, so that its original poisonous character disappears.

"Bird's foot trefoil (Lotus corniculatus), with brilliant orange and crimson tints of its little papilionaceous flowers, is known to every one. To produce this vividness and luster the epidermal cells are swollen into papillæ, and contain no less than three distinct pigments. There are the solid carotin corpuscles and also two coloring matters in solution in the cell sap. One is a clear yellow juice, the other is identical with the anthocyan of the rose. Where the latter predominates we get the deep red color.

"The tiny flowers of the cheerful little yellow bedstraw (Galium verum) contain carotin, much yellow resinous matter, and 'a curious purplish substance (possibly purpurin) insoluble in cold alcohol or benzine after purification.' The flowers also contain a species of ferment which, like rennet, has the power of coagulating boiling milk. A substance known as rubichloric acid is present, not only in the flowers, but in the stem and root. It forms a colorless solution in water, but when boiled with a few drops of hydrochloric acid suddenly produces a deep blue, then a green color, and deposits a dense, dark green precipitate soluble in ammonia. The disk florets of the daisy are tinged with carotin granules; the crimson of the ray florets is due to a soluble pigment described as a tannin anhydrid. The blue of the harebell and chicory is again a tannin derivative.

"Two coloring matters are engaged in the decoration of the primrose. At the base of the petal limbs, where the tint is more deeply orange, carotin granules are present; the rest of the corolla contains a pale-yellow, soluble pigment. Although the tints are comparatively feeble, chemical analysis shows that the plant is capable of 'an infinitely richer wealth of coloration' than it shows in our climate, since 'it seems almost impossible to exhaust the flower heads of substances which yield vivid and powerful orange and yellow dyes.'"

NAVY FULL DIET TABLE.

After much study the medical officers of the navy have adopted a new full diet table in which every care has been taken to provide for a proper quantity of proximate principles in a variety of food suitable for a liberal diet, says The Army and Navy Journal. For each meal in the table running through a week, the precise amounts of albuminoids, carbohydrates and fats were arranged, bearing well in mind the preferences developed by a seaman's life. The bills of fare represent not only the ideal poor man's food, but food that cannot be surpassed for royalty as well. It is found in practice, from the returns of all hospitals, that these meals cost an average of 30 cents per day per person, or about 10 cents per meal. The tables are thought to constitute the best possible fare, and represent a most excellent foundation for carrying other gastronomic luxuries. The naval full diet table is as follows for one day in the week, the number after each article relating to ounces: Breakfast—Coffee, 1; bread, 4; butter, 1; milk, 6; sugar, 1; oatmeal, 1; beefsteak, 6. Dinner—Rice soup, 8; bread, 4; roast beef or roast or boiled fowl, 8; potatoes, 8; other vegetables, 6; pickles, 1; bread pudding, with sauce, 6, or custard, frozen, 8; fresh fruit, 6. Supper—Tea, ¼; bread, 6; butter, 1; milk, 2; sugar, 1; cold roast mutton or cold roast beef, 4; stewed dried fruit or baked fresh fruit or apple sauce, 4. The staples—coffee, bread, butter, milk, sugar and fresh and dried fruit—are the same for each meal, but there is a daily variety in meats and other articles for breakfast, dinner and supper. The proportions are about the same, however, especially in the matter of meats, as in the specimen diet table given above. In addition to its use for convalescents, the table is now observed for all naval hospital employes, and is gradually becoming the standard aboard ship and in the marine corps. Its adoption was the result of most patient and thorough investigation conducted by Surgeon J. D. Gatewood, who consulted all the leading authorities on the subject.

ENGINEERING NOTES.

The war department is working on a new method of protecting gun emplacements as a substitute for masonry and concrete. An experimental emplacement is being erected at Fort Washington with a protective shield of worn-out railroad rails. This work is within range of some of the 10-inch guns which constitute a part of the Potomac River defenses at this point. A test will soon be made on the efficiency of this type of protection against heavy projectiles.

A method of centrifugal casting has been recently introduced and described by P. Huth in Stahl und Eisen by which castings similar to the ordinary chilled castings can be produced in the following way: The mould is made to rotate, when a hard steel is poured in, which flies to the sides; soft steel is then poured into the hollow center, with the result that the casting produced has a soft core and a hard face. The author suggests many applications, among which are wagon wheels with hard rims, projectiles with hard points, gear wheels with hard teeth, jaws for ore crushers, stamp dies with hard faces, plow points, and hard surface rolls of all kinds. Although both metals are intimately combined, yet the limits between them are said to be readily recognizable.

The committee of the American Society of Civil Engineers on the proper manipulation of tests of cement (of which committee Prof. George F. Swain, of the Massachusetts Institute of Technology, is chairman), has issued to members and others a circular containing a very exhaustive list of questions upon the subject named. The questions cover the matters of chemical analysis, microscopical tests, fineness, apparent and true density, tensile and compressive strength, preparation for tests, etc. The circular bears evidence of the most careful preparation, and the importance of the subject is great. The committee desires a wide circulation of the questions and suggestions or information upon any branch of the subject. It is suggested that those who have an interest in the matter will find it of advantage to communicate with Prof. Swain, at Boston, Mass.

According to Engineering News, rammed soil is being used as foundations at the site of the Paris Exposition of 1900, by M. Dulac, one of the contractors. In cases of made ground, or when the soil is loose, he uses a steam pile driver and a conical ram, with which he rapidly makes deep holes about 3 feet apart. These holes are filled with some hard material after each blow, and this material is forced sideways as well as down. The process has been patented by M. Dulac, and he claims that by thus using a suitable quantity of hard material he can make a good foundation for his superstructure, and save 30 to 40 per cent. in cost, as compared with the usual excavation, and do it in one-third the time. In very soft or water-soaked soil he proposes to use ashes mixed with a quick-setting cement; this lines the inside of the hole and produces a species of pipe for the passage of the ram. No material has to be excavated or carted away, and no bracing is needed. But he does not say whether he finally makes a continuous trench or simply a succession of holes filled with hard material, as in the case of the old, so-called, "sand piles."

The Manchester ship canal report for the half year ending December 31, 1897, is not pleasant reading for the stockholders, says Engineering News. The revenue from the Bridgewater canal alone enables the company to pay its fixed charges; and the profits from this source are greater in proportion than those from the ship canal, as the following figures show:

Ship canal receipts	$536,665
" " expenditures	441,630
" " credit	95,035
Bridgewater canal receipts	110,260

These figures can be better understood when it is realized that the books place the capital expended on the Bridgewater system at $8,921,755 and that on the ship canal at $66,889,255. The comparative interest is 1·25 per cent. on the Bridgewater canal and 0·14 per cent. on the ship canal; or, the former earns nine times as much on its capital as the latter. The traffic on the ship canal has grown, however, though less in proportion in 1897 than in preceding years. It is as follows for four years:

	1894.	1895.	1896.	1897.
Seagoing craft, tons	686,158	1,087,443	1,509,658	1,701,047
In barges, "	220,501	271,432	316,579	365,336

In a recent issue of Stahl und Eisen some interesting details are given as to the preparation of carbide of iron. It would seem that pure iron (Swedish or electrolytic) which is melted in the electric furnace in contact with pure carbon unites with it in increasing quantities as the temperature rises, and becomes more and more pasty, so that at the melting point of titanium it can no longer be poured. If the temperature is lowered, the metal again becomes liquid, and by letting it cool slowly and solidify, a gray button, full of graphite and with but little combined carbon, is obtained. By pouring into a chill while at about 2450° Fahr., white iron is obtained. If the material, while at 5400° Fahr., is suddenly chilled by throwing upon it some cold water, a product is obtained containing 5·25 per cent. of combined carbon, most of which is a carbide of iron, Fe_3C, which also exists in some quantity in steel. To get it in a pure form complete saturation of the melt and care to prevent the formation of graphite are essential. This can be well done, according to Moissan, by taking about a pound of Swedish iron, heating it in a graphite crucible for three minutes in an electric furnace with a current of 900 amperes and 600 volts, taking out the crucible and dipping it into cold water, which, by the way, can be done without danger. The hard crystalline mass is freed from surplus iron by remaining for twenty-four hours as an anode in a 7 per cent. hydrochloric acid solution, having a carbon plate for the cathode. The remaining carbide still contains some free carbon and carbohydrates, which are removed by letting it remain for some time in fuming nitric acid as free as possible from water, and to which a little potassium chlorate has been added toward the latter part of the process. The crucible is then washed in water, alcohol and ether. Under these circumstances, white crystals of Fe_3C, with a specific gravity of 7·07, are obtained.

ELECTRICAL NOTES.

It is stated by The Canadian Electrical News that the telegraph line which is to be built by the Canadian Pacific Railway, between Montreal and Vancouver, will cost $250,000. The wire to be used will be of copper, 300 pounds to the mile, and will weigh about 450 tons. It is being manufactured by the Dominion Wire Manufacturing Company, of Lachine, Que., and will be tested at McGill University under the direction of the officers of the company. The short pieces of wire which will be used to tie the telegraph wires to the insulators will have a total weight of 6½ tons.

Experiments have recently been carried out by Prof. Trowbridge, of Harvard University, by which he finds that the length of electrical discharges between widely separated points varies directly with the E. M. F. Discharges 4 ft. long were produced by means of an E. M. F. of 1,200,000 volts, and the professor made the calculation that for the discharge of a flash of lightning one mile long, at least 1,000,000,000 volts would be required. The apparatus with which the experiments were made consists of 10,000 Planté storage cells and a glass plate condenser of sixty leaves.

Experiments are about to begin at Tonawanda, on the Erie Canal, with a view to testing Prof. Short's plan of electric towage. The scheme is to haul a tow of boats by means of a locomotive on a track along and parallel to the canal banks. The mining type of locomotive is to be used, and it will be powerful enough to haul a tow of five boats, each of 50 tons burden, at a speed not exceeding six or eight miles an hour. The overhead trolley system is to be used in the experiments, and in its main features it is practically a street railway system, the locomotive, or motor car, hauling the boats behind it.

That well known electric railway, the little line which runs from Brighton to Rottingdean, England—some four miles in all—has proved so useful since it has been in work again, after the havoc wrought by the storm of December 4, 1896, was repaired, that a demand arose for an intermediate station to serve the village of Ovingdean, a retired place in a hollow of the chalky down half way between Brighton and Rottingdean. A station has been for some time under construction to meet this need, and has now been opened. It is built out at the foot of the chalk cliffs, on the seaward end of a jetty, to which access is gained by staircases cut in the chalk.

The Chemical Society of the Massachusetts Institute of Technology, composed mostly of instructors in the chemical department, have described recently a new process of preserving meats, says the English Electrical Engineer. The process proposed is simply to sterilize the meats by placing them for a certain number of hours close to an electric light. The actinic rays of light, not only from an electric light, but from almost any kind of light, are fatal in time to all kinds of germs, even in the bacteria of anthrax. While the meats are exposed to the light, a stream of hot air at temperatures ranging from 115° F. to 150° F. is sent up through the box in which the meats are placed to dry them. Then the thoroughly dried meats are powdered, and are thus ready for Klondike expeditions and for army and navy use.

In an article in a recent issue of The American Electrician Mr. H. S. Hering states that, as the result of tests, he finds the difference between making a stop and a start at a station and running past it varies from 75 to 100 watt hours, depending upon the gradient and load. The average value under ordinary conditions for a partially loaded 7½ ton car is 85 watt hours. Assuming the cost of electrical energy to be 1 cent per kilowatt hour, one stop would cost 0·085 cent, and the cost of making one unnecessary stop on each trip for fifteen trips daily would amount to $4.67 per car per year, and for 100 cars $467 per year for the one extra stop per trip. About 74 per cent. of the total energy required for propulsion is expended in accelerating and lifting a car, showing that if only one-half of the energy stored in a moving car could be saved, the saving would be very large. By careful driving a saving of from 10 to 20 per cent. might be effected.

According to L'Industrie Electrique, it is proposed to build an electric tramway between Rome and Genzano with a branch in the direction of Rocca di Papa. The line will be of normal gage, and the rails will be laid on oak sleepers placed at distances of about 3 feet apart. The steepest gradient will not exceed 9 per cent. and the sharpest curve 92 feet radius. The length of the line will be about 26 miles, divided into three nearly equal sections forming a Y. The generating station is to be at Capanne di Marino at the center of the Y, and will comprise five Dowson gas engines, each of 120 horse power, driving continuous current dynamos. One of these three sets constitutes a reserve. The station will also supply light to the streets and villas of Castelli Romani. The adoption of gas engines is primarily due to the lack of water. Overhead distribution at 1,200 volts is used with the rails as return. Motor cars are to be used with one or two trailers as required. The speed will vary from 9½ to 18½ miles an hour, and each motor car will carry two 35 horse power motors.

There are a few women in this country who have received a technical education in electricity, and one that we can call to mind at the present time is practicing the profession at Pittsburg, holding a position of some responsibility with the Westinghouse Electrical Manufacturing Company, says the New York correspondent of The Electrician. Another instance of the business capacity of women in this direction is that of a Southern lady, who is an electrical engineer and contractor, and seems to be equal to the average engineer of the male persuasion. Another woman, this time in Ohio, has acquired some prominence as a superintendent of a prosperous electric railway. She is only twenty years of age, and from all accounts is not behind her male competitors in operating the line. In New York State there is a woman wire contractor, and she does considerable business in this line, in her section of the State. New Jersey also enjoys the distinction of having an eccentric person, who runs an electric car on one of the Jersey roads. She seems to be fascinated with the work; but it is stated she has recently been persuaded to give it up, chiefly on account of the objections on the part of her men companions on the road and of her husband.

SELECTED FORMULÆ.

Reducers.—The best of these is undoubtedly Belitzski's; it keeps well in the dark and may be used over and over again till the solution turns yellow, and does not require the negative to be freed from hypo:

Potassium ferric oxalate	20 g.
Sodium sulphite	20 "
Distilled water	250 c. c.

Dissolve and add

Oxalic acid (crystal)	7·5 g.

and shake till the blood red solution turns green, decant from any undissolved acid and filter and add

Hypo	125 g.
Distilled water to make	1,000 c. c.

This is applicable to negatives, transparencies and bromide papers.

Varnishes.—Amateurs are not fond of varnishing, but the advantages are decidedly great as regards the permanency of the negatives. One of the greatest objections to the use of varnish is the necessity of heating the negative. Therefore, a cold varnish is preferable.

GOLD SIZE VARNISH.

Japanners' gold size (best)	Equal parts.
Benzole	

This is to be applied cold, and sets in half an hour to a very hard resistant film.

ZAPON VARNISH.

Thin transparent celluloid	20 g.
Acetone	300 c. c.
Amyl acetate	200 "

The objection to this is the unpleasant smell and the time the varnish takes to thoroughly harden.

Film Varnish.—As the basis of all films is celluloid, it is obvious that some varnish without a celluloid solvent as the vehicle must be used.

Bleached or pale shellac (powdered)	125 g.
Liq. ammonia fort	250 c. c.
Absolute alcohol	250 "

Macerate for 48 hours and then digest in a water bath till the shellac has dissolved and add

Distilled water to	1,000 c. c.

Filter.

This may be applied to the wet or dry films, and the best way is to put sufficient varnish in a dish and bodily immerse the films and then hang up to dry.

ORDINARY NEGATIVE VARNISH.

Pale yellow shellac	150 g.
Sandarac	18 "
Castor oil	1 c. c.
Absolute alcohol (or old methylated)	1,000 "

The negative must be heated before this is applied.

CRYSTAL VARNISH (FOR TRANSPARENCIES).

Gum dammar	50 g.
Benzole	1,000 c. c.

This can be used cold. It is not so resistant as those given above.

Toning Baths.—For the old albumenized paper it is usual to employ neutral or alkaline baths, and acetate, phosphate, tungstate or borate of soda are generally used. A typical formula is:

Gold chloride	0·4 g.
Sodium acetate	16 "
Distilled water to	1,000 c. c.

Gelatino-Chloride Toning Baths.—The best formula is the following; it is suitable for all kinds of papers, though with some it yields finer tones than others:

Gold chloride	1 g.
Potassium sulphocyanide	2 "
Distilled water	180 c. c.

Dissolve and heat to the boiling point for five minutes and add distilled water to make 200 c. c.. For use mix 1 part of this with 15 parts of water.

Combined Toning and Fixing Baths.—Amateurs will have these, but their use should be discouraged as much as possible, but the following is a simple formula:

No. 1.

Lead nitrate	10 g.
Hypo	200 "
Distilled water	1,000 c. c.

No. 2.

Chloride of gold	10 g.
Distilled water to	100 c. c.

This solution must be absolutely free from acid. Just before use mix 5 parts of No. 2 with 1,000 parts of No. 1. The prints must be bathed in a 1 per cent. solution of bicarbonate of soda, well washed, and then immersed in the toning bath.

A Combined Toning Bath Without Lead.—

Hypo	240 g.
Ammonium sulphocyanide	24 "
Sodium acetate (fused)	48 "
Distilled water to	1,000 c. c.

To this, just before use, add 1 gramme of neutral chloride of gold.

Developer for Gelatino or Chloride.—It is not generally known that gelatino or collodio chloride paper can be developed, and in the winter time or in summer, when a large number of prints have to be obtained, this is a great advantage. The paper should only be faintly printed, just sufficient to show all the details, and then developed with the following:

No. 1.

Hydroquinone	10 g.
Alcohol	100 "

No. 2.

Sodium sulphite	100 g.
Citric acid	5 "
Distilled water to	500 c. c.

For use mix 50 parts of No. 1, 50 parts of No. 2 and 1,000 parts of water. Development will be complete in from 10 to 15 minutes, and the prints should be transferred to a 5 per cent. solution of salt, well washed and then washed in the combined toning and fixing bath.—Pharm. Jour.

FIVE EARLY ASTRONOMERS.

EVERY science has its history, and that of astronomy especially is full of romantic incident. Early astronomers are referred to at considerable length in the SCIENTIFIC AMERICAN SUPPLEMENT, No. 836, and we will now briefly touch upon the lives of five great astronomers—Copernicus, Tycho Brahe, Kepler, Huyghens and Galileo. The sixteenth century is one of the most notable periods in the history of science. It is the period in which astronomy, after remaining for hundreds of years barren of great discoveries, acquired new life by the Copernican reversion to the theories of Pythagoras and Aristarchus.

COPERNICUS (1473–1543).

Astronomy began to be cultivated in Germany in the fifteenth century, and during the sixteenth century that country was the scene of the labors of Copernicus, Tycho Brahe and Kepler.

Nicholas Copernicus (1473–1543) was a native of Thorn, Polish Russia. He early manifested a taste for science, especially astronomy. He attended the University of Cracow, and he profited so well by his instructions that he obtained the doctor's degree and was soon after appointed professor of mathematics at Rome. He entered the church and was appointed to a benefice which enabled him to devote his leisure to his studies. After giving up many years to observing the motions of the celestial bodies and meditating upon the systems of Ptolemy and the Pythagoreans, he drew up his celebrated treatise "*De Revolutionibus Orbium Celestium*," which completely changed the science of astronomy.

The results of his studies convinced him of the falsity of the then accepted theory and demonstrated the truth of the system which he had formulated, and for twenty-six years he continued to test his now familiar theory before he announced it, and, in fact, his work was published only a few days before his death in 1543. The Copernican system supposes that the earth revolves in a circle, in the plane of which circle the sun was situated, and that the earth also turned on its axis every twenty-four hours, as if it rolled on the convex circumference of its orbit, which would cause the sun to appear to move round the heavens in a year, in a direction contrary to that of its diurnal motion. He stated that the evidence of the senses which attribute movement to the sun and stars is an illusion.

The reasoning by which Copernicus supports his views is not, however, always so sound; for he often uses arguments which are as frivolous as those of the Aristotelians he undertook to refute. He attributes to the celestial bodies motion only in perfect circles, and accepts the doctrines about "natural" motion and "violent" motion which Aristotle laid down. Copernicus advanced some speculations on gravity which read almost like an anticipation of Newton's great idea. Copernicus wished to encounter as little opposition as possible. So Rome was avoided, owing to the possible enmity of the Catholics; and Wittenberg was also avoided, owing to the contempt in which the Protestant Melanchthon held astronomy. So Nuremberg was selected. It was considered advisable to prefix an apologetic preface, which stated that the new doctrine was put forth only as an hypothesis. He was encouraged by some ecclesiastical friends to publish his astronomical doctrines, which proved so obnoxious to the theologians of every creed. Among men of science Copernicus received little recognition at first, and they brought forward the old absurd arguments. There were exceptions, however, as Moestlin, who was the instructor of Kepler.

TYCHO BRAHE (1546–1601).

Tycho Brahe (1546–1601) was a Dane. While a student at Copenhagen he eagerly studied astronomy, and when he afterward went to Leipsic to study law, he spent most of his time looking at the heavens. He inherited a fortune and traveled extensively in Germany, and after his return to Copenhagen he dabbled in alchemy and astronomy and discovered a new star in Cassiopeia in 1572. He entered all his observations in a manuscript volume. The King of Denmark treated Tycho kindly and gave him the use of a fertile island in the Baltic. A splendid residence and observatory were built for him. It was strangely like a castle of romance. There were ramparts, gateways, towers, subterranean crypts and vaulted chambers. There were libraries, workshops and museums, and the king spent $100,000 and Tycho laid out a like sum, and the latter christened it "The Tower of Heaven" (Uraniberg).

The astronomer lived here twenty-one years, observing the phenomena of the heavens and keeping open house for scientific men. He spent nearly all his fortune on the observatory, and the king granted him an annual pension and gave him an estate and appointed him to a sinecure office. His munificent patron died and the new king deprived Tycho of the means of carrying on his labors. Tycho removed all his apparatus and books and with his family retired to Rostock. He then went to a friend's chateau, near Hamburg, where he completed his work entitled "*Astronomiæ instauratæ Mechanicæ*," and he secured the friendship of the Emperor Rudolph by the dedication of it to him. Tycho was invited to Prague, and he received houses for residence, observatory and laboratory and a handsome pension. He died at Prague in 1601.

The improvements which Tycho made in astronomical instruments added not a little to his reputation. His instruments surpassed in size and workmanship all that had before been constructed. The larger dimensions afforded space for more minute subdivisions of the graduated limbs, and by employing in addition the means of reading small divisions, which is now so well known as the "diagonal scale," Tycho made a catalogue of the fixed stars surpassing in accuracy the catalogue of Ptolemy. Tycho had four clocks which indicated hours, minutes and seconds. His largest clock had only three wheels, but one of them was three feet in diameter and had 1,200 teeth. He made important observations on comets. He rejected the Copernican system of the world and proposed a system of his own which was between the Copernican and the Ptolemaic. In this, the earth was supposed to be stationary in the center, the sun and moon revolving daily about it, while the planets revolved about the sun, which, in its motion round the earth, was supposed to carry all the planets with it.

The long series of accurate observations made by Tycho became a great storehouse of facts from which another great astronomer of a different genus obtained the means of deducing the laws of planetary motions. When Tycho, in the fifty-fourth year of his age, was carrying on his observations at Prague, he was assisted by an eminent astronomer, John Kepler.

John Kepler (1571–1630) was at Tycho's death appointed his successor as mathematician to the emperor. The salary allowed him was inadequate to support him; so he resorted to the practice of casting nativities as a means of adding to his resources. In the year 1609 Kepler published his great work entitled "The New Astronomy; or, Commentaries on the Motion of Mars." This remarkable book formed the connecting link between the discoveries of Copernicus and those of Newton, and upon which chiefly rested the scientific reputation of its author. The inquiries which led to his discoveries had been entered upon when Kepler first became Tycho's assistant, but it was the observations of the Danish astronomer which furnished the data for the endless calculations made by Kepler in successively testing one theory after another, until he had hit upon one according to the facts. The first of the three celebrated theorems called Kepler's laws was, first, that the planets move in elliptical orbits around the sun, which is placed at one of the foci; second, the law which he deduced in the course of this investigation is famous among astonomers as the "Law of Equal Areas."

KEPLER (1571–1630).

Kepler was conducted to brilliant results by a method very different from that by which others have advanced to great discoveries. His reasons were often vague, and very frequently rested on no other foundation than arbitrary assumptions, but Kepler had much mathematical knowledge, and his perseverance in calculations which would appall most men was something extraordinary. He would assume a hypothesis almost at random and work out its consequence by laborious calculations. He then carefully compared the results which he had obtained with actual observation. If

they contradicted it, he abandoned the hypothesis and tried another, repeating his calculations on the fresh supposition, however formidable the labor this might involve, and again reaching the hypothesis which led to results discordant with the facts. Before he arrived at the true nature of the orbit of Mars, Kepler tried no fewer than nineteen other paths. The twentieth guess proved to be the right one. The appearances were in agreement with the supposition, and Kepler announced that the orbit of Mars was an ellipse, thus overthrowing the ancient prejudice concerning circular motions which had so long checked the progress of astronomical science and preparing the way for the grand discoveries of Newton.

At last he obtained the arrears of his salary, and in 1613 he was appointed to a professorship of mathematics at Lintz, where he passed sixteen years of his life, and where he published in 1619 a work entitled, "The Harmonies of the World," containing announcements of three of his celebrated laws, that, namely, of connecting the distance of a planet from the sun with the period of its revolution. This law is expressed mathematically by saying that the squares of the times of the revolution are proportional to the cubes of the distances. About the same time Kepler published a work entitled, "An Epitome of the Copernican Astronomy." This book contains his reasonings in astronomy, presented in the now popular question and answer form.

Christian Huygens or Huyghens was born at the Hague April 14, 1629, and he died there June 8, 1695. He was a celebrated Dutch physicist, astronomer and mathematician. He discovered a satellite of Saturn in 1655 and the ring of Saturn in 1659; he invented the pendulum clock in 1656; he improved the telescope and developed the wave theory of light. He wrote "*Horologium Oscillatorium*" (1673).

Galilei was born February 18, 1564, in Pisa, where his father was well known as a mathematician. When seventeen years old he went to the University of Pisa to study medicine and physics, and the latter directed his attention to the natural sciences, which possessed great attractions for him. The teachings of Aristotle, who had lived nearly 2,000 years before, formed the foundation for this branch of science in the time of Galileo, but the young student soon saw that his standpoint was far behind the times. This led him to investigations which resulted in the discovery of very important mathematical and physical laws. The most ordinary events supplied him with subjects for study, and as Sir Isaac Newton was led by the falling of an apple from a tree to the discovery of the laws of gravitation, so the swinging of a hanging lamp in the cathedral of Pisa led Galileo to the not less important theory of the pendulum, in which he recognized the means of accurately reckoning time. Later he invented the hydrostatic balance—an instrument for determining the specific gravity of bodies—fixed the laws of the center of gravity of bodies and established the existence of magnetism.

In 1589 Galileo became professor of mathematics in the University of Pisa, and his lectures were received with enthusiasm by the students, but his opposition to the philosophy of Aristotle aroused the ill will of many, who made his position so uncomfortable for him that he accepted a similar chair in Padua. Here he found his proper sphere, and from year to year the number of his intelligent hearers increased. During this period of his life Galileo accomplished his greatest work and made his most important discoveries, such as his study of mechanics and dynamics, the invention of the thermometer, the reconstruction and improvement of the telescope, etc.

The latter made it possible, for the first time, to carry astronomy into scientific channels, giving a firm basis to that which had always before rested on supposition and hypothesis. With the help of the telescope Galileo discovered the mountains of the moon and calculated their height; the satellites of Jupiter, the rings of Saturn, the spots on the sun, the rotation of the sun around its axis, and many other interesting things about the heavenly bodies, and of great importance as beginnings of the study which convinced him of the truth of the Copernican theory, according to which the earth has a double movement, while the sun is the central body of our system of planets.

After teaching eighteen years in Padua, Galileo was called as mathematician and philosopher to the court of the Grand Duke at Florence, where he was able to devote himself entirely to study. Here also his labors were rewarded by a number of important discoveries in the realm of astronomy and physics; but he again found himself exposed to the attacks of his enemies, the number of whom was increased by jealousy of his fame. In spite of this, however, he declared openly and without reserve his belief in the theory of Copernicus. This did not meet with the approbation of the powers of the church, who considered the theory heretical and contrary to the text of the Bible. The Inquisition possessed a power which was almost unbounded in questions of belief, and this power was defied only at the risk of death at the stake. But the brave champion of his convictions was not intimidated; in a letter to the Jesuit Castelli, he explained that in questions of natural philosophy, not the Bible, but science should decide, and that this was not the province of priests, but of scientists.

This bold letter did not go unnoticed. It reached the Inquisition at Rome in 1615, and an investigation was immediately begun. Whether the dreaded judges in clerical garb were restrained by the already celebrated name of the great investigator or by the intercession of his friend Cardinal Barberini—who was afterward Pope Urban VIII.—is not known, but no sentence was declared against Galileo, although the teachings of Copernicus were condemned as heretical. Galileo escaped, for a time, the grasp of the "holy" Inquisition, but his sharp answers to the charge drew upon him the enmity of the Jesuits.

His friend Barberini was made Pope in 1623, and he went to Rome to secure the removal of the sentence condemning the writings of Copernicus, but Pope Urban VIII. would not run the risk of setting aside the decision of the Holy College for fear of being suspected of heresy, and, therefore, Galileo's efforts were unsuccessful.

Now he carried out his long cherished plan of setting forth his opinions in regard to the theory of his great predecessor, which he wrote in the form of a dialogue between the adherents of the old and new schools, the result of the discussion being, of course, the triumph of the new theory over the old.

Scarcely had Galileo's book appeared when it was seized by the Inquisition, and an inquiry against the author begun. He was summoned to appear before the judges and defend himself, but, knowing that he could not count on their leniency this time, he tried to escape the journey to Rome, but in vain. In 1633 the gray-haired old man of sixty-nine appeared before the Holy Office to answer the charge which the zealots had brought against him, the principal ground of complaint being his disobedience of the command of 1616 to renounce the theory of Copernicus. In answering the charges he limited himself to the statement that he had no desire to place himself in opposition either to the text of the Bible or to the statutes of the church, and did not consider that his science was at variance with them.

In order to save his life, which would otherwise have been sacrificed at the stake, he had to deny on his knees the truth of the opinions he had expressed and the theory that the earth moved. When the oath had been administered and he saw the judges nod to each other with a malicious air, all the pride of the savant impressed by the truth of his knowledge was roused in the old man, and he spoke, in a tone of deepest conviction, the celebrated words, "It does move, for all that!"

For the rest of his life Galileo was a prisoner of the Inquisition, although they did not throw him into jail, like a criminal. He was allowed to live at Arcetri, near Florence, with the strictest instructions not to leave the parish. All his movements were watched and reported to the Inquisition. He passed nearly nine years here, in a sort of banishment, living exclusively for his work, until the indefatigable worker was at last overcome by the burden of years. Bodily pain embittered the last years of his life, and he finally became totally blind. He died January 8, 1642, mourned by his friends, who, although very numerous, could not save him from the persecutions of the Inquisition. For our engravings we are indebted to Der Stein der Weisen.

THE PRESENT APPEARANCE OF JUPITER.

IT may be interesting, now that the planet Jupiter is very favorably situated, to call attention to a few of the more conspicuous features which diversify its surface. Many of these objects will be sure to have come under the repeated observation of all those observers who have been habitually examining the planet in their telescopes.

It is fortunate that at the present time there are a large number of conspicuous markings on the planet. These are situated in different latitudes, and will allow some excellent redeterminations to be made of the velocities of the various longitudinal currents.

There are a great many dark and bright spots visible near the equator, on the north side of the southern equatorial belt. Some of these at the date of writing (April 18) are placed in the following longitudes, which are computed on the basis of System I. (daily rate 877·90° = 9 h. 50 m. 30 s.) in Mr. Crommelin's ephemerides in Monthly Notices for January, 1898.

	Bright spots.	Dark spots.
Long.	80	71
"	146	94
"	209	116
"	238	127
"	270	155
"	349	216
		279
		319
		355

These markings are moving at approximately the same rate as the zero meridian System I., but I find that in several cases there is a disposition of the spots to decrease in longitude; hence I believe that their rotation periods will prove to be slightly less than 9 h. 50 m. 30 s. The bright spots exhibit great variations in their appearance, and some irregularities of motion. A spot which is conspicuously brilliant on one night may, a few evenings later, have declined so much that it can scarcely be discerned.

The great red spot is still visible, and its present longitude is about 24°, so that it follows the zero meridian of System II. in the ephemerides by about forty minutes. The spot has the aspect of a faint dusky ellipse with a light interior, and it is connected on its south side with a gray belt. The recent motion of the spot corresponds with a period of 9 h. 55 m. 41·5 s., and it may be expected to drop further behind its computed place unless an acceleration of motion should set in. Comparing an observation of the spot which I obtained on April 17, 1898, 12 h. 5 m., with one of the earliest by Mr. Dennett, of Southampton, on July 27, 1878, I find that 17,414 rotations were performed in the interim of 7,203 days, and that the mean period of rotation was 9 h. 55 m. 39·4 s. This value is identical with that found by Prof. Hough from 14,505 rotations between 1879–96.

In July, 1898, the spot will have been visible during twenty years, and under careful observation at each opposition of the planet. Whether this object is identical with other elliptical or reddish spots seen at various times in the same latitude by Dawes (1857), Huggins (1858–59), Gledhill (1869–70), Lord Rosse (1873), Copeland (1873), Russell (1876), and others, must remain an open question. It appears highly probable that the spot was the same as that observed by Russell in the summer of 1876, but there is an absence of connecting observations in 1877. And the identity of two or more markings cannot be absolutely proved by their longitudes when a fairly long interval has intervened between the observations, because the proper motions of the object are variable, and introduce great differences of longitude not always in the same direction. The retarded westerly drift of the red spot has caused it to lose more than 900° of longitude relatively to its place in 1878, so that the spot has really been displaced to the extent of about two and a half circumferences of the planet.

From my own observations of the spot since 1880, I

HUYGHENS (1629–1695).

GALILEO GALILEI (1564–1642).

have obtained the following rotation periods for a certain interval during each apparition:

Limiting observations.		Rotations.	Period. h. m. s.
1880 Sept. 27	1881 March 17	... 413 ...	9 55 35·6
1881 July 8	1882 March 30	.. 640 ...	9 55 38·2
1882 July 29	1883 May 4	... 674 ...	9 55 39·1
1883 Aug. 23	1884 June 12	... 710 ..	9 55 39·1
1884 Sept. 21	1885 July 8	... 700 ...	9 55 39·2
1885 Oct. 24	1886 July 24	... 659 ...	9 55 41·1
1886 Nov. 23	1887 Aug. 2	.. 609 ...	9 55 40·5
1888 Feb. 12	1888 Aug. 22	... 462 ...	9 55 40·2
1889 May 28	1889 Nov. 26	... 439 ...	9 55 40·0
1890 May 22	1890 Nov. 25	... 451 ...	9 55 40·2
1891 Aug. 7	1892 Feb. 2	... 432 ...	9 55 42·2
1892 Aug. 15	1893 March 8	... 495 ...	9 55 42·3
1893 Aug. 9	1894 March 24	... 548 ...	9 55 41·2
1894 Nov. 25	1895 May 10	... 401 ...	9 55 41·2
1895 Aug. 24	1896 Feb. 22	... 439 ...	9 55 41·3
1896 Sept 27	1897 April 25	... 514 ...	9 55 40·8

The red spot has been falling behind the zero meridian during the last six or seven years, but at a very slow rate, the mean annual retardation being only about six minutes.

There are a number of dark, elongated spots or short belts placed in various regions of the planet. They are conspicuous objects on nights when the seeing is good, and the times of their passages across the planet's central meridian are easily secured. The following are the longitudes of a few of these formations as computed from System II. of the ephemerides:

	Long. °
1. Dark elongated spot in Lat. + 15 ...	120
2. ,, ,, Lat. − 35 ...	150
3. ,, ,, Lat. + 15 ...	254
4. ,, ,, Lat. + 33 ...	268
5. ,, ,, Lat. + 39 ...	282
6. ,, ,, Lat. + 15 ...	298

Nos. 1, 3 and 6 are placed in the bright tropical zone, and immediately outlying the northern edge of the north equatorial belt. They are moving somewhat faster than the red spot, as their longitude appears to be decreasing at the rate of about 10° per month. Nos. 4 and 5 in the north temperate zone are moving at approximately the same velocity as the red spot.

There are some well defined irregularities in the north side of the northern equatorial belt, which exhibits both white and dark spots. Their motion is evidently controlled by a rapid current similarly to that of the white and dark equatorial spots, but not, perhaps, quite so extreme.

Bright spots appear in the zone south of the red spot, and several of these are being attentively followed with the object of determining their periods.

On the whole the planet's appearance is now singularly replete with detail, and will compare favorably with that exhibited at any previous opposition. The great red spot has, it is true, long since lost the intense brick red color it displayed in the years 1878–81; nor have we now the exceedingly brilliant white equatorial spots of the period named. But appearances are now visible on the disk which were absent then, and among the most interesting of these are the elongated dark spots situated just outside the margin of the north equatorial belt.

Though past observation has fully demonstrated the proper motions of the different markings and the decreasing velocity of several of them, it is highly important that the rate of the various currents should be redetermined every year. The character and number of the spots found in them should also be recorded, and measures made to determine the latitudes of the belts. Pursued through a long series of years, such data might ultimately give us the proof of periodical variations in the character and number of the spots, and possibly also in their rates of motion.—W. F. Denning, in Nature.

[Continued from SUPPLEMENT, No. 1169, page 18706.]

AMERICAN COMPETITION WITH FRANCE IN AGRICULTURAL PRODUCTS.

FROM A FRENCH POINT OF VIEW.

UP to the present we have spoken of things only—of crops, processes of cultivation and of technical and scientific education in its relations with the agricultural industry. It is proper now to speak of the men, that is to say, of the farmers. Let us in the first place distinguish the landed farmer, who has been established in the country for a long time, and the newly arrived immigrant.

The former alone is really American, in language, habits, thought and tradition. It cannot be said that he is so by race, since the majority of the citizens of the United States are evidently Europeans; but the mixture of types and races has been so oft repeated and the alliances have been so diverse and so numerous that from this fusion of different elements there has been created a characteristic personality—the "American."

In the Far West, the immigrants preserve the physiognomy and characters peculiar to their race. We find here Swedes, Norwegians, Germans, Poles, Hungarians, Irish, Scotch, English and French Canadians. All these men have doubtless become, or are to become, American citizens. They speak English (at least away from their fireside), and time, daily relations with the American and intermarriages will work a gradual transformation and give birth to a new type. At present, it is none the less true that such transformation is not finished and that the new type does not exist. True colonies of Germans, Swedes and Canadians have, moreover, been formed at certain points. A community of language, traditions, origin and religion groups and binds these immigrants together.

So the idea that is held in France as to the American farmer of the West is in most cases erroneous. We seem to think that it is a question of the descendant of the English colonists who settled in New England in the seventeenth century! This is a ridiculous error. There is no doubt that "Yankees" are to be found in the West, but they constitute a minority and are an exception to the rule. The role of those that are there met with is quite special. It is that of banker, "land agent," speculator, broker or tradesman. If he is engaged in agriculture, the Yankee is a rich, active capitalist who has bought a large extent of land and who puts it to profit while waiting for a chance to sell it at an advance, by lots, to the new settler, that is to say, to one who will cultivate it for a long time by virtue of positive ownership.

Remark, moreover, that the role of the Yankee money lender, speculator and temporary land holder is extremely important, delicate and useful. In the course of our travels in the Far West we heard loans at heavy interest, advantage taken of the farmer, speculation, etc., bitterly spoken of; but it plainly appeared from our examination that, without the aid of these venturesome money lenders, the farmers would in most cases be unable to succeed in procuring the capital necessary to start with. Application is made to these men because it cannot be helped.

The owner who has purchased his land in order to sell it later on, when there shall be a "boom" in it, also displays extraordinary activity. His exploitation is share farming. Yes; this is very true; but he contributes by that very fact toward improving a region. He employs ruined farmers to whom it would prove very difficult to find elsewhere a use for their activity and the means of effecting a saving. The petty farmers whom he employs to cultivate a portion of his domain borrow from him in this way the working capital that they need.

That is what American capital does and the part that it plays in the West. The task that it performs, however, is as difficult as it is perilous. It is particularly risky, in fact, to make loans to farmers, whose qualities of endurance, activity, energy or probity are not easily ascertained. It is none the less perilous to undertake to improve a farm of from 4,000 to 20,000 acres, to get together the help for it, to manage it, to maintain it, and to risk large sums in the hope of some day realizing a profit when the value of the land shall have increased.

In our older country we but too rarely find any of those bold land owners who set themselves to work, direct the cultivation of their domain, reside upon their property and play the role of the Western Yankee. In our eyes, land is a home site. A person buys a farm in order to invest his fortune safely and preserve it from the fluctuations in the prices of commercial paper or from the reverses that might happen to men whose all is invested in business.

Therefore, the principal, if not the sole thought of the bourgeois landlord is to collect his rents or his share of the crop regularly, to repair the buildings on his domain, and to keep watch of his tenant, if need be, in order to see that he cultivates like a "good father of a family," as the civil code has it. Thus understood, the role of the landlord is for all that useful. The very renting out of a well maintained domain provided with adequate buildings, hay, forage, and often domestic animals also, is, in reality, an operation of credit. The landlord puts at the disposal of the farmers a capital five or six times larger than the fortune of the tenant. When it is a question of the metayer, it is the landlord again who furnishes everything that is indispensable for cultivation.

The direct action and influence exerted by a French landlord is, however, less marked than in the case of the American one, who shapes, manages and, in a manner, creates his rural domain. With much greater reason is the difference sensible between the French landlord and the American farmer of Iowa, Indiana and Illinois, States that have been colonized for thirty or forty years, and in which there exists a host of farmers who own the land which they cultivate. To what are such differences due? They are explained by habits. In France, we still have the profoundest contempt for the profession of agriculture. Without reason and without reflection, we confound the head farmer, that is to say, the industrial agriculturist who manages an exploitation, with the domestic or farm laborer. In the eyes of those ignorant city folks who are the slaves of their prejudices a farmer can be nothing but a rustic, a serf of the glebe bent over the furrow, and, in a word, a "peasant"! It is in vain to try to make people of the world understand that a farmer must not be confounded with a farm hand any more than the superintendent of a factory must be confounded with his workman. It is in vain to repeat that it is just as honorable (and difficult) to cause grain to sprout or to breed cattle intelligently as it is to manufacture sugar or calico caps. If you even add that the profession of agriculturist requires, in order to be practiced with talent and profit, just as much knowledge as does that of trader, manufacturer or functionary, that a farmer may be an honest man in every respect, that his situation renders him independent and assures him an income that is often very large, and an active and healthy life, your labor will be in vain. The prejudice is there, living, majestic and ridiculous, but nevertheless respected.

Independently of the prejudice that exists in our country in regard to farmers, another opinion concerning agriculture must be noted. There are many persons who believe that it is impossible to realize large profits from the cultivation of land. And what is the proof? It is that the capital invested in the purchase of a rural estate brings but 2½ to 3 per cent. Truly, this is making fun of the world and reasoning in a strange manner. The land rented by an owner who does not cultivate it yields a small revenue as compared with its cost price. This is very true, but it simply proves that the competition of purchasers has gradually raised the price of the land and that one pays very dearly for a small revenue in order to be sure of not losing the capital itself.

This proves nothing as regards agricultural profit, that is to say, the gain realized by the farmer through the capital that serves to make the soil produce. Now the working capital gives a revenue per cent. three or four times higher than that of the landlord. If the latter gets 2¼ or 3 per cent., the farmer obtains 7, 10 or 15. That is the truth.

It is none the less true, unfortunately, that the two prejudices of which we have spoken exercise a detestable influence upon the fate of our agriculture. They turn away from the fields the activity and capital that ought to be applied to them for the greatest profit of our country.

We do not extract from the soil all the wealth that it might yield us. We condemn young, active, intelligent men, who seek an office instead of living free and happy in contributing toward the development of their country, to a narrow life without independence, and sometimes without dignity.

We must do the Americans justice to say that no prejudice exists in their minds on the subject of the farmer and agriculture. A man who was yesterday a banker, physician, lawyer, engineer or merchant will in nowise think that he is lowering himself by becoming a farmer. The quality of man of the world appears to them to result less from the profession that one follows than upon education, the elevation of ideas and the extent of knowledge. Many American statesmen have been farmers. At present there is observed, seemingly without surprise, a farmer holding the office of Secretary of Agriculture, and his antecedents do not appear to work to the detriment of his authority or to diminish his prestige.

What, moreover, characterizes American society and social life is the extreme instability of situations. Such or such a man who is to-day a merchant may to-morrow be a farmer or a politician. The farmers therefore do not form a class in which they remain included. To-morrow, a functionary or a physician who has bought a farm may not find a tenant, and be obliged to cultivate it himself, to install petty farmers on it for working it on shares, or, if need be, to erect a factory or mill upon it. How, then, can the man who but yesterday was seen in a business office and who six months later will be met in a drawing room be treated contemptuously as a "peasant"?

In France, a landlord who is accustomed to collect his rents regularly sees them abruptly diminish; and he grieves over it. If his farm finds no purchaser, he rises up in judgment against heaven and earth, asks the protection of the state with loud cries, and invokes his rights to the stability and regularity of his income, and even to its increase—a sure sign of public prosperity!

In the United States, such a state of crisis and instability does not stir up so much feeling and cause so many complaints. The landlords act instead of talking and occupy themselves with turning their land to account without asking the government to protect them.

It would doubtless be easy to cite active landlords in France and supine men in the United States. Yet all impartial observers will admit that people are too indifferent in our country, and, up to the present, have been too much so in regard to matters relating to the soil.

But, it will be said, all landlords have not the time to busy themselves with their domains, and, moreover, after a piece of land has been well rented to a responsible under-farmer, what more is to be done?

This latter observation is very just, and our criticism does not apply to the owner of a domain intrusted to the management of an active farmer who is sufficiently rich and skillful. Unfortunately, there exist thousands of farms that are not in this felicitous situation. If their owners are unable or do not know how to work them, let them apply to some of the agricultural engineers who have graduated from our schools, that they may group themselves among them in order to cultivate a surface of considerable extent and reduce the expense of administration. Whenever they decide to do this they will succeed; but it is necessary to have the courage and intelligence to break with the prevailing prejudices. It is necessary to be bold and to regard with calmness the new situation of our European agriculture.

It is not the processes of cultivation employed in the United States that it is well to imitate or servilely copy. It is the energy, initiative, boldness and spirit of enterprise of our rivals that it is indispensable to possess in order not to succumb miserably in the contest engaged in with them.

It is estimated that there are in France more than two million five hundred thousand landlords who cultivate their own heritages. It is not to these that our observations apply. They are suffering much less from the agricultural crisis than the farmers, the metayers and the landlords who are content to rent their land. Finally, many landed farmers, especially in the South, are, in effect, exploiting their domains with the aid of a manager or a head man.

We are thinking especially of the landlords of large and average means who own metairies that are too often abandoned to the mercies of an under-farmer destitute of knowledge and resources. We are thinking likewise of those who are unable to rent their land or who are forced to submit to large reductions in rent.

In most cases there would be reason for modifying the systems of cultivation practiced by farmers and for tracing a new plan and rapidly modifying the execution of it according to the market price of the commodities. It is impossible at present to cultivate the soil of France with profit as it was cultivated thirty years ago. It is of little consequence that this is a misfortune; we are obliged to undergo such transformation. Well, in a new situation, it is necessary to employ new processes and to utilize a working force having other traditions and other attainments.

Yesterday, it was cereals that it was well to cultivate; to-morrow, it will be stock raising and fattening and dairy farming that it will be necessary to prefer.

Taking into account the natural capabilities of the land, it is variety in the productions that should be aimed at in order to attenuate, in some cases, the effects of the decline in market prices, or to take advantage of a momentary rise in them.

If a rise in the market price of forage, hay and other cattle food takes place, it is necessary to be able to substitute for these commodities some sort of alimentary industrial refuse, so that the products of which the sale will become advantageous may be put upon the market.

A decline in the price of live stock should furnish the occasion for a purchase. Variations in the market price should likewise determine the selection of such animals of the bovine, ovine, and porcine race as one prefers to raise or momentarily fatten.

Add to such economic and commercial considerations researches relative to the use of fertilizers, irrigation, drainage, choice of seeds, cultural process, etc., and one will be able to understand how delicate the task of an intelligent farmer, knowing how to cultivate with profit, must henceforward be.

The best method of teaching and of popularizing technical agricultural knowledge is that of example. What would not be the range and efficacy of the improvements introduced and of the development of the wealth obtained in twenty or thirty domains in France if the landlords cared to occupy themselves therewith, or to intrust the management of such enterprises to an educated, active and experienced person.

For the last fifty years we have been seeking in France the solution of a financial problem: that of agricultural credit. It is especially for the benefit of farmers and metayers that it appears useful to organize a rural credit.

In the United States this question has not even the same character, although it is still more important. As the farmers are almost always landlords, they can use their land as security. In most cases, the farmer finds credit with a banker, who does not hesitate to accommodate him. Such operations are everyday occurrences.

In France our large and average landowners do not borrow in order to cultivate, since they scarcely cultivate, and, on another hand, it does not occur to them to loan money to their tenants. If, on the contrary, they chose to occupy themselves with agricultural matters, or if they intrusted the management of their domains to competent men, they might, were it necessary, borrow upon mortgage, and employ in cultivation a sum of money that would prove productive. The problem of rural credit would thus be partially solved.

A close union, an intimate association of the landlord and tenant, in cases where the latter is himself not a landlord, would, we believe, be an efficient remedy for the present crisis, which especially affects the tenant or the occupant of a rented farm.

We have said, and we repeat, that in the United States people are suffering like us from a decline in the prices of agricultural products. It is the energetic initiative of the landlords there that has permitted of attenuating the effects of it. In France, we shall succeed in obtaining the same result only by employing the same means.

The sons of our landlords should acquire a solid agricultural education, and should themselves supervise the cultivation of their domains.

In all cases where this solution of the question cannot be adopted, the landlords ought to have recourse to technical managers, to genuine agricultural engineers to directly exploit or supervise the use of the capital intrusted to the farmer or metayer.

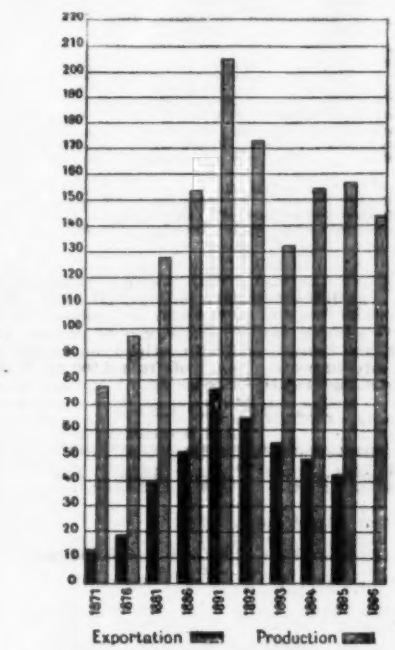
To-day, this new idea will have the fate of everything that is new; it will not be accepted. People of the world will treat us as Utopians, but on the day on which their revenue diminishes to the point of becoming nil, on the day on which they will have observed the realization of this idea at different points, they will emerge from their lethargy and understand that it is wise to occupy themselves with their business or to intrust the care of it to those who are capable of preserving them from ruin.

This, it will be said to us, is the whim of a pessimistic writer. We shall triumph over foreign competition by our customs duties. Have you not said yourself that the Americans have been raising less wheat for some time and that they could not export more than a quarter of their product? The development of their population will some day force them to reduce the amount of their exports still further and our European farmers will be saved.

These hopes, alas! appear to us to be very chimerical. Let us put aside the question of the tariff, which is a political one, and speak of American competition. It is true that at certain points the cultivation of wheat has disappeared or lost its importance in the United States. But, as an offset, such cultivation is extending in measure as new land is cleared. In reality, the production is developing.

As for the exports, they are not diminishing, but are changing form. Instead of wheat being exported in the grain, it often happens that it is shipped in the form of flour.

Apropos of this, examine the accompanying figures. The first relates to the production and exportation for a few years. The crops are without doubt larger than the shipments, but it is plain that neither decreases. The second relates to the exports of wheat in grain and to those of flour. The latter gradually increase. The former follow the oscillations of the orders from Europe, but there is nothing to show or allow to be foreseen a sensible and prolonged reduction. Although it is an exaggeration to attribute the decline in wheat to American competition alone, it would be impossible, in return, to deny the importance of this economic factor. What we say of wheat is true of the other cereals and of live stock. And then, we repeat, much is said about the United States because the public has been much struck with the wonderful stories relative to the Far West and the immense fields of wheat. But it is the entire world, now, that is developing its agricultural production. The old countries themselves are trying to increase the production of their soil in the hope of supporting themselves and of compensating for the decline in the market price of commodities through an increase in the output. European colonists go to Asia, Africa and Oceanica to obtain from new lands new products, which, in their turn, come into competition with the agriculture of the mother country.



PRODUCTION AND EXPORTATION OF WHEAT IN THE UNITED STATES.

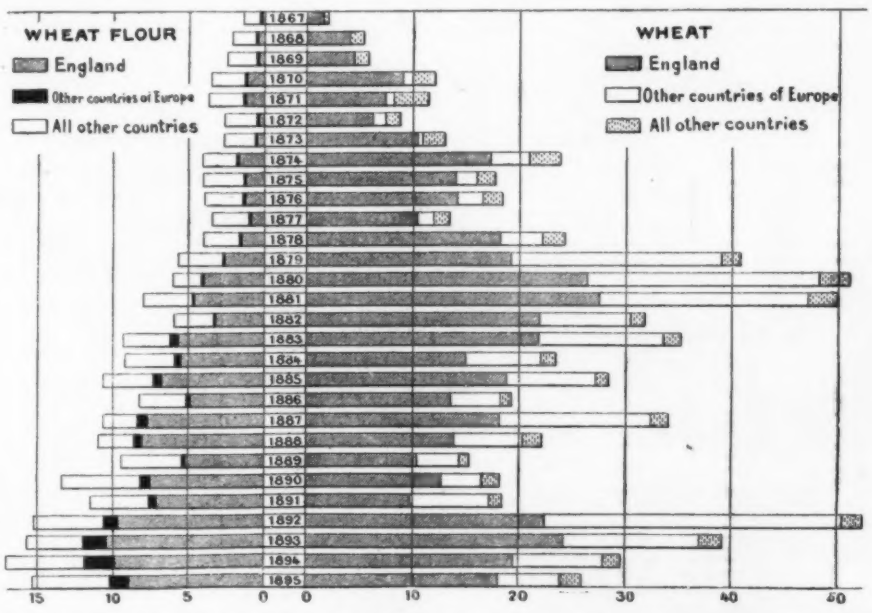
Apropos of this, pessimists and sophists say: "All is lost, we are ruined!" It would be indeed strange if an abundance of wealth were a cause of ruin and if men died of hunger because they produced too much wheat, corn, meat or milk. The truth is entirely otherwise.

What difference exists between France and the United States or any other new country from the viewpoint of agricultural production? Our land is as fertile, our climate is more favorable, the wages paid farm hands are lower, our ways of communication are more numerous, and the wealth that we have acquired is greater; and, finally, we have no need to go to a distance to seek consumers. Our situation is therefore not so perilous as people are pleased to say that it is.

Land, it will be said, is of a higher price in France. That is true, but this circumstance simply proves that the cultivation of it permits of realizing larger profits. The revenue and the price of land will, moreover, decrease in France and in Europe if such profits happen to diminish further.

It is the landed proprietors that will support the weight of the agricultural crisis, and, among these, the most disastrously affected will be the owners of domains submitted to the regime of rent charges and metayage. Let them therefore get rid of their illusions and set themselves to work.

We have pointed out the remedy, it is for them to apply it resolutely—D. Zolla, in L'Illustration.



EXPORTATION OF WHEAT AND WHEAT FLOUR FROM THE UNITED STATES.

A GOVERNMENTAL DEPARTMENT OF SCIENCE.

By Prof. J. H. GORE, Columbian University.

ONE of the questions periodically brought forth for discussion is the advisability of establishing a Department of Science, in which all of the scientific work of the general government shall be concentrated under one chief. It is said that each of our larger bureaus now prosecuting scientific inquiries has a director with an executive corps consisting of a chief clerk, private secretary and disbursing officer; that many have a special library, with a librarian and assistants; that not a few sustain laboratories with similar names if not identical functions, and that each is deprived of the support of the others, while all lack the strength which union alone can give. The corrective suggested for avoiding duplication of directors, chief clerks, librarians, etc., and the remedy for the dispersion of energy now volatilizing in so many workshops is to consolidate, to have one great Department of Science; in short, to centralize.

The advocates of this scheme declare that "in union there is strength." That is unquestionably true if the elements to be united are "compatibles," if the methods are the same, and the results equally the property of all.

A department such as proposed would be either independent, with a cabinet officer at its head, or a bureau under one of the departments now existing. If the latter arrangement were effected, its weakness can best be emphasized by merely suggesting the effect upon scientific work in case the secretary of the department of which the bureau in question happened to form a part should be inimical to science in general or to the director in charge of the scientific bureau. In many departments efficient directors of technical bureaus are retained from one administration to another, and we rejoice when partisanship is ignored in such retentions. But by no means seldom does it occur that the difference in the party affiliations of a director and his secretary is a source of misfortune, and cuts in estimates, or modifications in recommendations, are the consequent results. Under the present arrangement it is not probable that such a conflict would exist in all of the departments, or between any one secretary and all of the directors in his department. So that if for one year, or even for four years, science in one department should suffer, it might thrive in all the others.

Again, suppose we have a cabinet officer in charge, with the directors of the important bureaus as now constituted as assistant secretaries. Then with each administration a new Secretary of Science may be expected, together with a change in the corps of assistant secretaries. The continuity of work in the separate subdivisions, therefore, would be possible only by having a chief clerk or assistant in charge of the office as a "hold-over," so that, after all, the mechanism would be just as complicated as now, with the exception, perhaps, of the librarians and disbursing officers.

If such a consolidation were practical, would the results be enhanced? It is doubtful. Scientific work is special and the workers are individuals—not units of one whole. Elementary work, like elementary instruction, can best be done in classes; but original investigation is carried on by one person. Years ago, in driving piles, a large number of men hoisted, by main force, the weight which, in falling, furnished the driving power; now, with the elaborate mechanism and highly differentiated activities, one man, by simply opening and shutting certain valves, accomplishes the work more quickly than a score of men could have done in the days gone by.

The demand for specialization is nowhere so great as it is in the scientific bureaus at Washington. Many problems that come up for solution come but once, but they come by groups and the groups seldom overlap. The work is therefore highly differentiated, and coalition would be its bane.

It may be argued that it is not our purpose to train specialists, but to attain results which have a practical bearing. The ultimate object is the one named, but the theoretical investigation must precede, and if it has not been prosecuted by some one else, our specialist must be prepared to take it up before the practical question which rests upon it can be decided. It would be folly to send out inspectors of cattle until the germs of contagious diseases are identified, and the expert is not content with the identification of well-known forms, but searches for others. The astronomer need make but few observations in obtaining all the data required for the preparation of the Nautical Almanac, but the methods of observation and reduction now employed were once new and were the outcome of patient investigation. Even if we have no desire to pay to the future the debt we owe the past, our astronomers find encouragement to work in the hope of making discoveries which will be of immediate use.

Fortunately, no one is called upon to plead the cause of pure science; on the contrary, all are ready to encourage specialization, and the dictum is repeated that specialization is promoted by differentiation, while centralization is its worst enemy.

Before leaving this point, something ought to be said about the work of the government scientist. For many years it was thought to be right and proper, as well as clever, to look down upon government reports, and many believed that they were printed simply for members of Congress to use as a sort of valentine—books to be sent to influential constituents to show that they were not forgotten. Large numbers find in this their only use, but thousands go into libraries and into the hands of scholars, who take from their pages facts and observations with which to substantiate some hypothesis or round out a suspended conclusion. It is safe to say that there is not a single text book of science of recognized value in this country that has not gathered data from government reports—data so specialized that private investigators would never venture to seek them. Thus the oft-mentioned taxpayer is receiving in a thousand-fold measure returns from the appropriations made for science, while his sons and daughters are storing up facts gathered by the aid of these annual grants. Congressmen recognize this to be true, and whenever they feel that the resources of the government permit it, they cheerfully vote sums for the conduct of purely scientific

work. The great trouble is to induce the secretary to lay proper emphasis upon the importance of some special work. But, as said before, in the aggregate better results may be expected from seven secretaries than if one alone should act in the interests of scientific work.

An advantage often quoted in favor of unification is the avoiding of over-lapping work. It is true that three organizations, for example, are engaged in hydrographic work, but the objects in view are so different that the data obtained by one would not answer the needs of another, nor would one general drag net set of observations secure all that might be wanted without including an equal amount that none could possibly use.

It sometimes happens that our two great surveys cover approximately the same territory, but for totally different ends. One makes over a limited area such observations that when a comparison is made between them and a series of an earlier date, the exact gain or loss of material can be ascertained. For instance, suppose a bar is forming across a river's mouth; it is necessary, before attempting to arrest its formation, to know where the material comes from. If it is sand, a neighboring coast must furnish the supply; but whether it comes from the north or the south will depend upon the currents, and the exact spot can be known from the wear observable in the comparison as mentioned above. A topographic survey furnishing such exact data would waste time in making a map intended to show only the towns, prominent elevations and lines of communication. The map-making party can utilize locations established by the one first named, and the two bureaus engaged in topographic work exchange data as freely as though they were under one department.

There is no particular reason why the Coast Survey should be in the Interior Department, and it is quite likely that the Geological Survey would not fare so well under the Treasury Department as it does where it is, while how either would be improved if they were parts of a Department of Science is not apparent.

The chemical laboratories sustained at Washington are frequently cited as a flagrant illustration of the over-lapping. Here again a close examination would show that only in the rarest instances are the results of their investigations interchangeable. One discusses problems related to geology and mineralogy, another tests medicinal preparations, a third is interested wholly in organic substances, to another are committed questions relating to articles from which revenue is collected, while such delicate matters as how to make the most effective explosive and the best armor are referred to a fifth. To supervise these, laboratories are needed: an expert in organic chemistry, one in pharmacy, one in the examination of ferments, and one in explosives. A chief chemist remarked very wisely that "each assistant should know more about some one branch of the work than his chief, while the latter should know more about the entire field than any assistant." Imagine a chief chemist who could conduct, on this scheme, a laboratory in which all of the existing chief chemists were assistants! Only a man who knows all of chemistry could fill such a position—and that class of men died with Liebig. In many instances the results of chemical examinations are of value only as long as they can be kept secret. Even now it is difficult to maintain strict secrecy, when but a few could possibly surmise the character of the investigation in hand; it would be practically out of the question when scores of assistants were working together.

There would be considerable economy to the nations of the world if there were only one naval intelligence bureau, where all the countries would deposit complete and detailed information regarding the protection of their harbors, the defense of their cities, number of vessels, together with their armament, etc. But information so generally possessed would be of no value to any one.

Naturally, this condition would not be paralleled if all of our laboratories were united. Still it must be admitted that many facts, now valuable because they are supposed to be the exclusive property of our government, would be subjected to the danger of leaks when a larger number of persons could either directly or indirectly have access to them.

There is room in our rapidly growing land for a new department, perhaps a Department of Commerce and Industry. If such should be added, to it would fall some of the scientific bureaus—not because they are scientific, but on account of their relations to the industries and commercial interests. When these transfers are made the only effect, visible or otherwise, should be restricted to a change in the official stationery.

THE LAUGHING PLANT OF ARABIA.

THE Montreal Pharmaceutical Journal for May gives a description of the laughing plant and its effects upon man. It grows in Arabia and derives its name from the effects produced by eating its seeds. The plant is of moderate size, with bright yellow flowers, and soft, velvety seed pods, each of which contains two or three seeds resembling small black beans. The natives of the district where the plant grows dry these seeds and reduce them to powder. A small dose of this powder has similar effects to those arising from the inhalation of laughing gas. It causes the soberest person to dance, shout and laugh with the boisterous excitement of a madman, and to rush about cutting the most ridiculous capers for about an hour. At the expiration of this time exhaustion sets in, and the excited person falls asleep, to wake after several hours with no recollection whatever of his antics. The New York Medical Journal adds:

This description reminds us of a plant known in the Lower California Desert as the loco weed, which has a similar effect upon horses, driving them into a state of boisterous craziness.

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